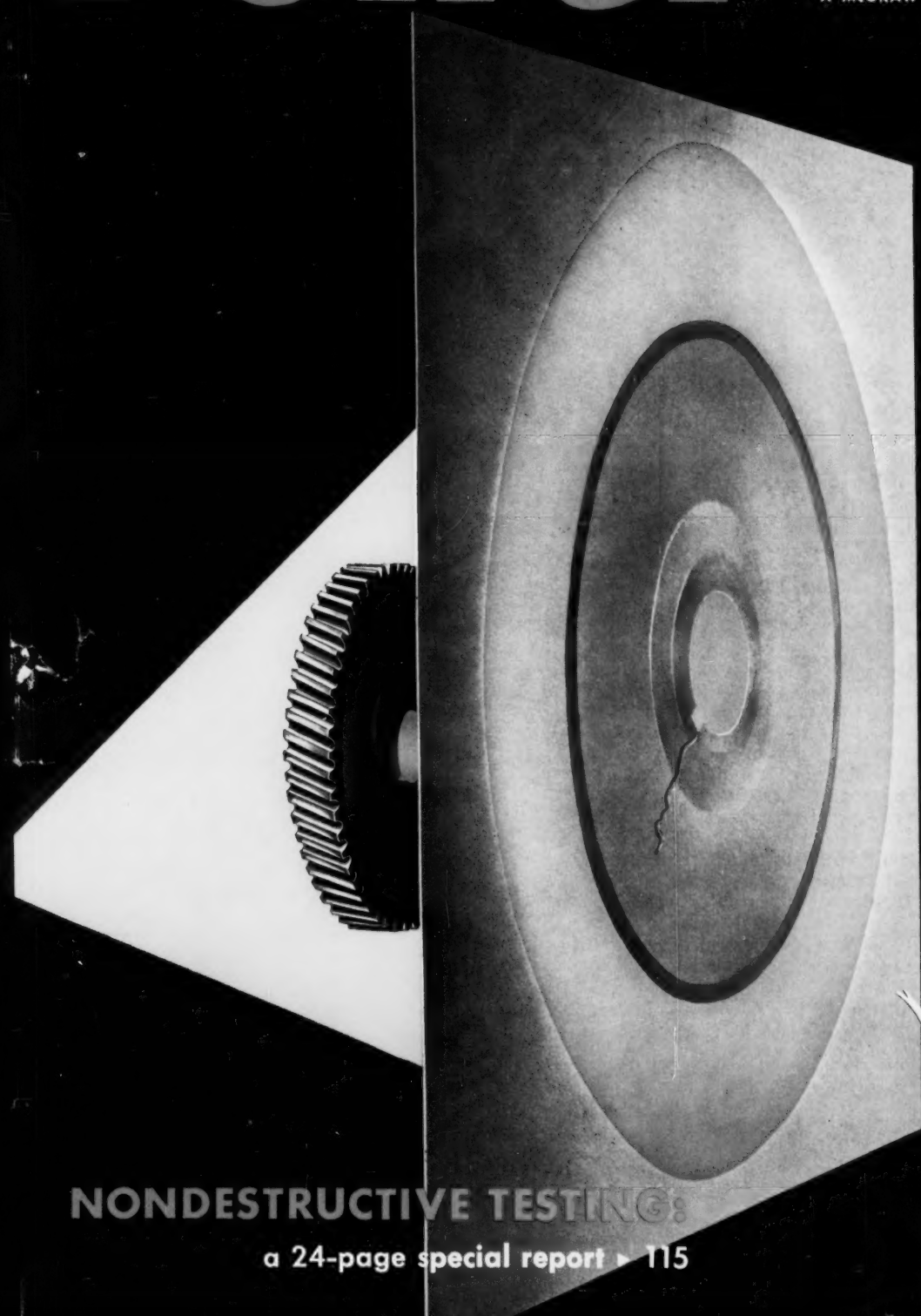
For engineers who design and manage the power and plant services

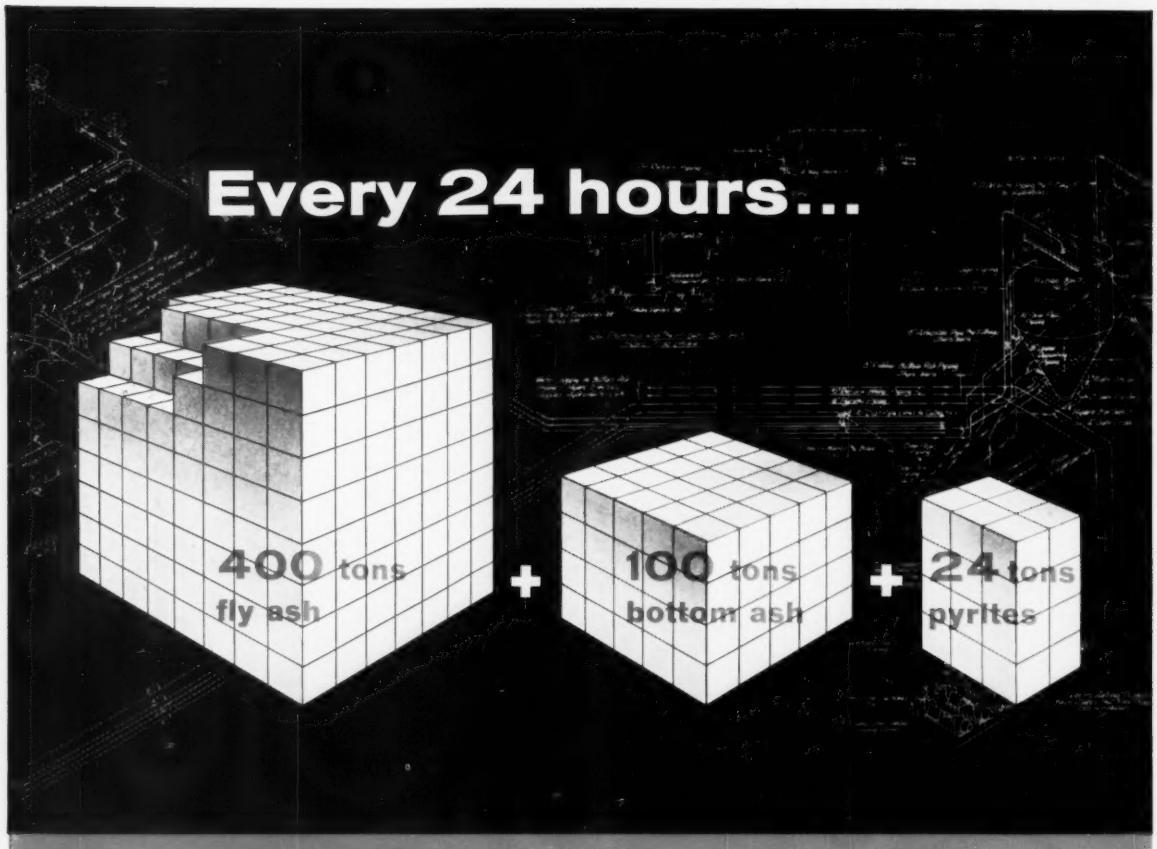
Power

MARCH 1958
ONE DOLLAR
A McGRAW-HILL PUBLICATION



NONDESTRUCTIVE TESTING:

a 24-page special report ▸ 115



will be removed and transported 900 feet at the new Eddystone Station, Philadelphia Electric Co.

A progressive step in power production will be realized next year when Philadelphia Electric's Eddystone Station goes into operation. Utilizing pressures and temperatures never before attempted (throttle steam condition for the first unit will be 5,000 psi—1,200°F.), the two units to be installed will produce 325,000 kilowatts of electricity each. This will be accomplished with coal consumption of *less than 2/3 pound per kilowatt hour.*

The problems of ash and pyrites handling for the Eddystone Station were solved by The Allen-Sherman-Hoff Company. The systems are completely automatic, with storage at a point about 900 feet from the plant. Ultimate disposal will be by rail car, truck or barge.

Bottom ash will be collected in water-filled hoppers and pumped to dewatering bins. This system will be completely closed; there will be absolutely no run-off water and make-up water will be held to a minimum.

Fly ash will be removed by four independent systems (each boiler is divided into half, each with its own system). Vacuum will be produced by water jet pumps, the water recirculating as part of the system.

Pyrites will be transported by a high pressure hydraulic system and discharged to either of the dewatering bins, where it will be handled with the bottom ash.

Few ash handling systems are this large, but *your problem, whatever its size, will be given the same careful consideration as is going into this installation.* Contact us today and gain the advantages of our many years experience in solving ash handling problems of all sizes.

A-S-H service doesn't stop with installation. When service problems come up, we stand ready to give prompt service assistance. This is a policy worth considering when suppliers are being selected.

MATERIALS HANDLING SYSTEMS

"Hydrojet" *hydraulic*

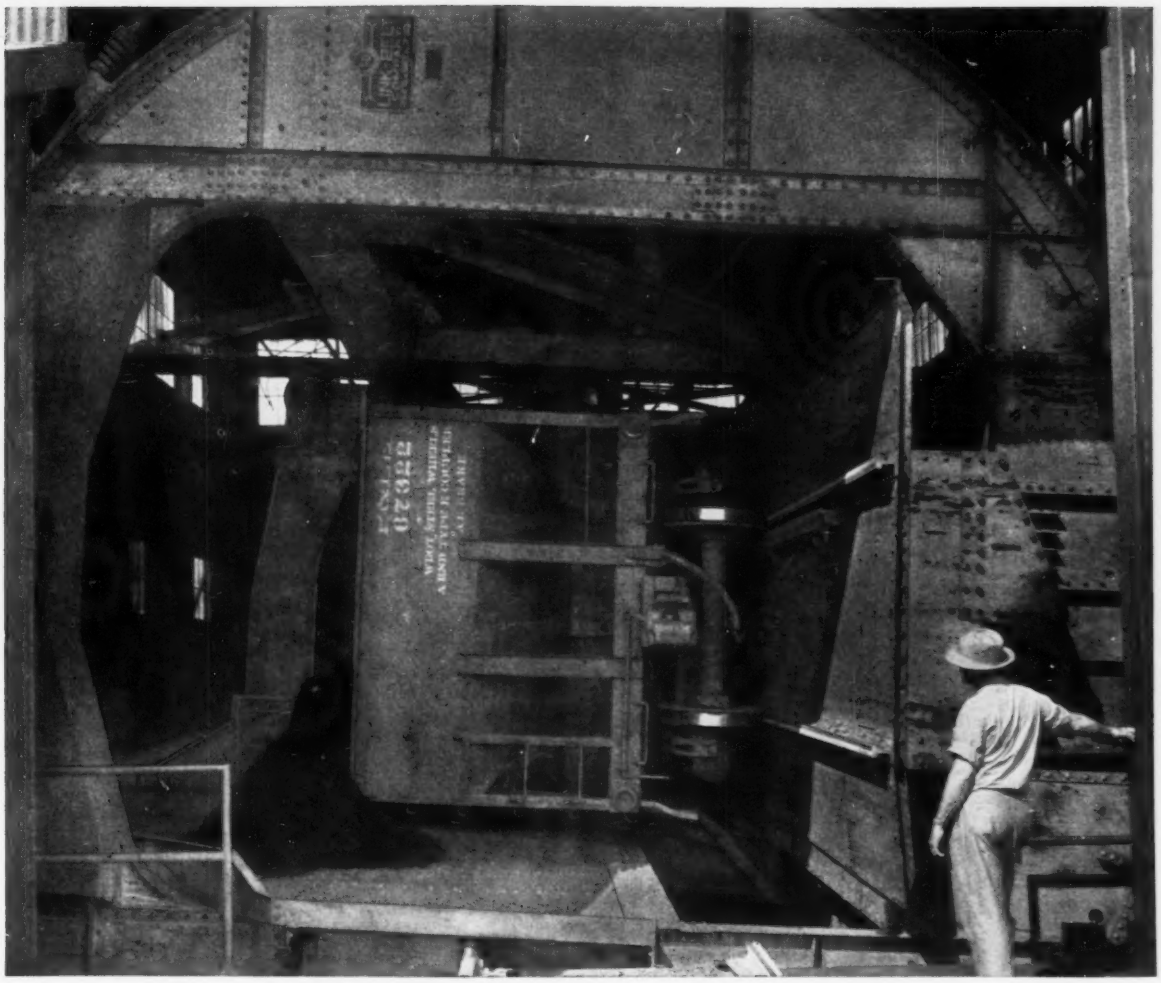
"Hydrovac" *pneumatic*

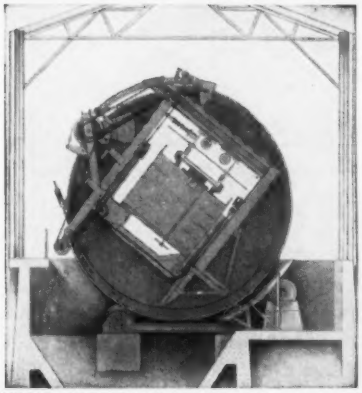
the **Allen-Sherman-Hoff** company

259 E. Lancaster Ave., Wynnewood, Pa.

Offices and representatives in principal cities

BOTTOMS UP





DUMPING CYCLE IS SIMPLE. With car in position, rotation is controlled by means of lever. As car begins to tilt, the transfer table moves sidewise until side of car rests against it. Simultaneously, overhead self-adjusting clamps descend on top of car and hold if securely to rails. Rotation continues until car is overturned. Dumper is automatically stopped by limit switch. Pushing lever in opposite direction returns the dumper to normal position.

LINK-BELT rotary car dumpers empty 90-ton gondola cars in 60 seconds

One minute and one man—that's all it takes to unload a carload of coal with a Link-Belt rotary car dumper. The entire operation is lever controlled—permits unloading of 15 or more cars per hour including normal spotting and handling time. This foolproof system handles gondola cars of all sizes, with capacities up to 90 tons . . . cuts costly demurrage charges . . . minimizes operational hazards and accidents. For facts, call your Link-Belt office. Write for Book 2048-A.

LINK-BELT

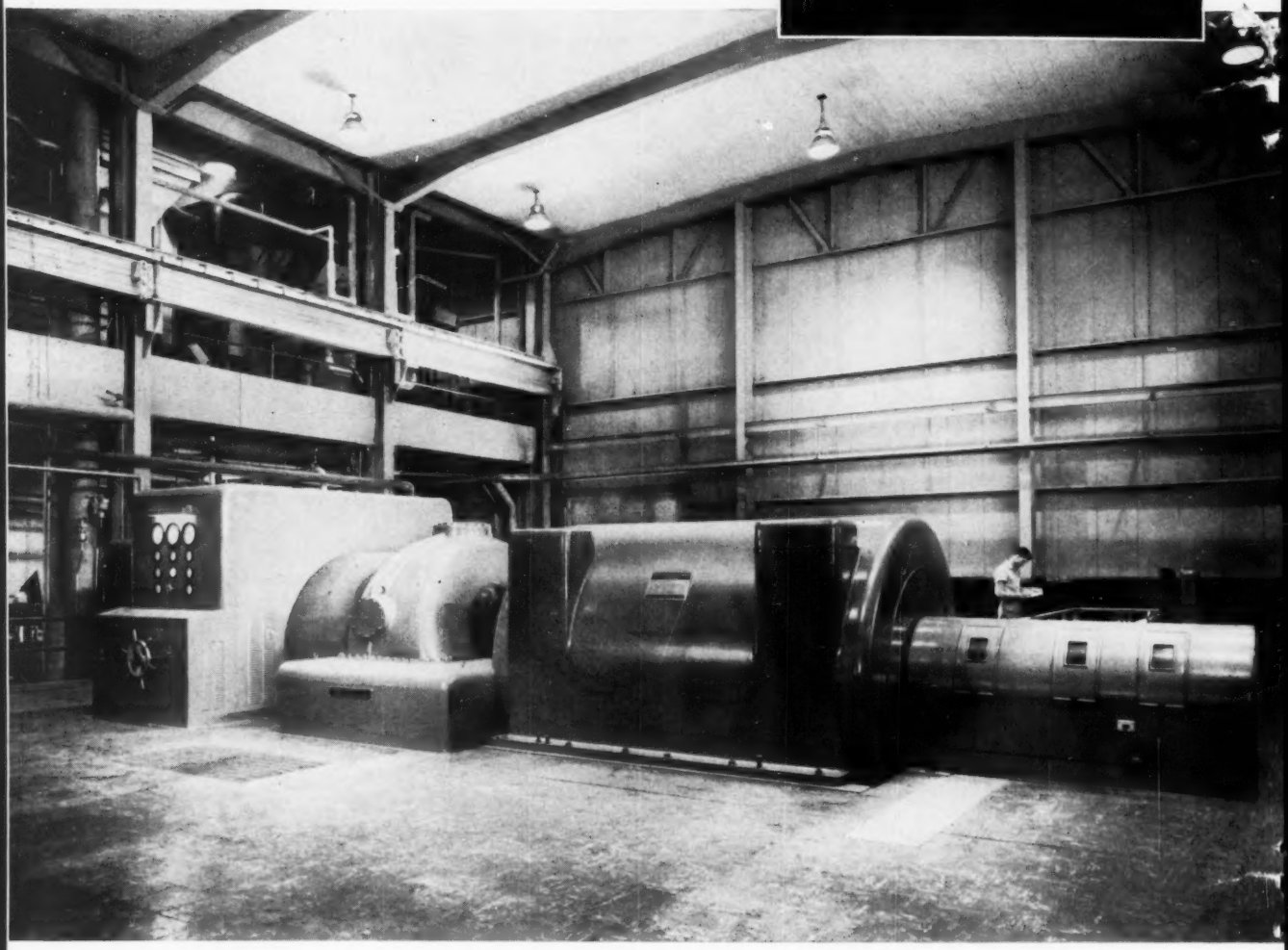
ROTARY CAR DUMPERS

14.570

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Henderson, Ky., selects a third

DE LAVAL
TURBINE
GENERATOR



In 1950,...
two De Laval 5,000 kw multi-stage turbine generators were installed in the central station of Henderson, Kentucky. These units operated so dependably that the City of Henderson ordered a new, larger De Laval turbine generator to meet their increased power requirements.

Put on the line in 1956,...
this 12,650 kw De Laval machine is an AIEE-ASME Preferred Standard Unit. It operates at 600 psig and 825F; the turbine speed is 3,600 rpm.

De Laval multi-stage turbines are rugged in construction, economical to run. Transmission of power may be either direct or through speed reducing gears. De Laval multi-stage steam turbines are available for all services, including operation at the high pressures, high temperatures employed in steam plants of the latest design. Units are built in sizes up to 25,000 hp.

DE LAVAL *Turbine Generators*

DE LAVAL STEAM TURBINE COMPANY
815 Nottingham Way, Trenton 2, New Jersey

DL-350

In Power this month

MARCH 1958 • VOL. 102 • NO. 3 • 76TH YEAR

Editorial: The growth of an idea ____ 75

DESIGN AND EQUIPMENT APPLICATION

New guides sprouting to help you plan electrical distribution ____ 79

Today's packaged firetube boiler ____ 82

Nuclear notes: News briefs on the latest developments ____ 86

Fuel for this diesel is washed and wrung dry ____ 87

How internal-combustion engines work: Thermo refresher No. 17 ____ 90

Welding copper-base alloy tubes: First of three parts ____ 94

A sound guide for condenser testing and operation ____ 98

Two-mile cooling-water circuit avoids recirculation at Memphis ____ 100

The British say it differently ____ 102

Spherical-head feedwater heater avoids leakage problems ____ 103

Space heaters lick motor moisture ____ 104

Transistors play a growing part in industrial control ____ 106

Now, a 4500-psi standard for valves: Last of three parts ____ 110

Data sheet: Seamless carbon-steel pipe ____ 111

PLANT MAINTENANCE AND MANAGEMENT

NONDESTRUCTIVE TESTING: A 24-page special report ____ 115

With the pressure on to keep machines humming, look to NDT as a practical maintenance technique for side-stepping downtime

Comment ____ 139

Practical ideas ____ 140

Plant problems ____ 144

How to: Apply portable diesels ____ 148

Plant electrical fact file: Finding opens in squirrel-cage rotors ____ 150

Basics: What determines speed of motors? ____ 152

Marmaduke Surfaceblow: Marmy's dry boiler ____ 154

READER SERVICE SECTION

This month's service index ____ 156

Reports from the field ____ 158

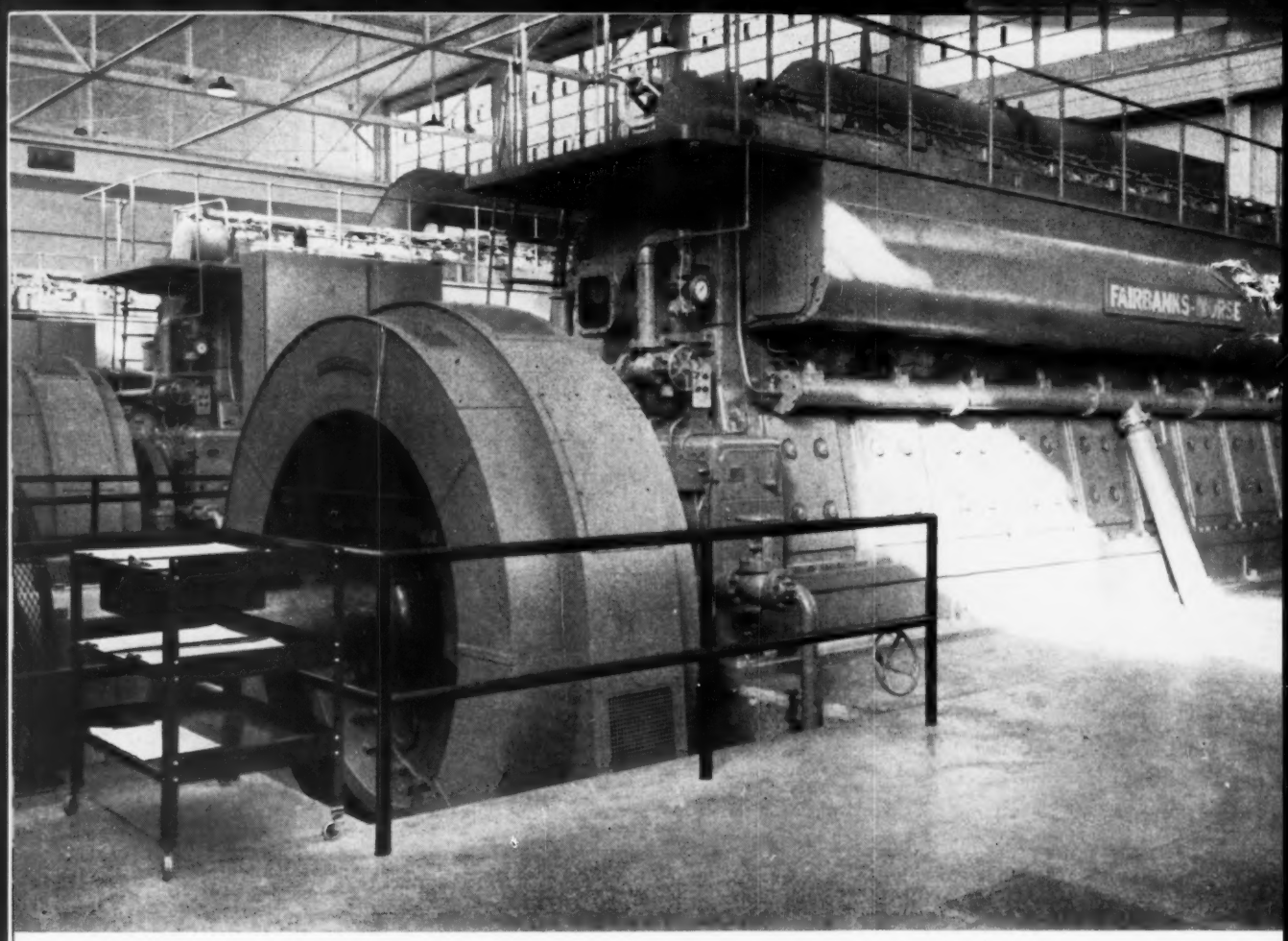
Technical briefs ____ 160

Plant equipment news ____ 164

New free literature ____ 171

George Edwards ____ 174

Print order this issue: 49,938



4 reasons why cost-conscious engineers specify TEXACO Ursa Oil Heavy Duty

Increasing the output of the individual engine is one way to hold the line on rising operating costs. And effective lubrication can play a major role in increasing diesel efficiency. That's why more engineers are specifying Texaco Ursa Oil Heavy Duty for optimum diesel operation. Here are the reasons:

- **Keeps engines clean.** Texaco Ursa Oil Heavy Duty is fully detergent and dispersive, resists oxidation.
- **Keeps rings free** for full compression and complete combustion.
- **Increases parts life.** Bearings, pistons, liners all last longer with Texaco Ursa Oil Heavy Duty.
- **Reduces cost** of maintenance, minimizes fuel consumption.

Carefully refined and fortified with effective additives, Texaco Ursa Oil Heavy Duty assures *more* power with less fuel over *longer* periods between overhauls. That's why, *for over twenty years, more stationary diesel horsepower in the U. S. has been lubricated with Texaco than any other brand.*

A Texaco Lubrication Engineer will gladly give you full details on the lubrication needs of all diesel, gas and dual-fuel engines. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TUNE IN... Metropolitan Opera Radio Broadcasts Every Saturday Afternoon

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

(PARTS, INVENTORY, PRODUCTION, DOWNTIME, MAINTENANCE)

L N ROWLEY — *Publisher and Editor*

B G A SKROTZKI — *Design and Application*
S M ELONKA — *Maintenance and Management*
J J O'CONNOR — *Managing Editor*
R C BELLAS — *Assistant Editor*
R H MARKS — *Assistant Editor*
N PEACH — *Assistant Editor*
A P SOMMER — *Assistant Editor*
A S THORNTON — *Assistant Editor*
C F MARSCHALEK — *Art Editor*
F A ANNETT — *Contributing Editor*

DOMESTIC NEWS BUREAU: *Atlanta, Cleveland, Detroit, Dallas, San Francisco, Washington*

WORLD NEWS OFFICES: *London, Paris, Bonn, Tokyo, Beirut, Rio de Janeiro, Mexico City*

CLARK BOUGHTON — *Sales Manager*

DISTRICT MANAGERS

ATLANTA 3, GA. – M H Miller, 801 Rhodes-Haverty Building, Walnut 5778

BOSTON 16, MASS. – J E Dean, 350 Park Square Building, Hubbard 2-7160

CHICAGO 11, ILL. – L W Romigh and G L Crane, 520 North Michigan Avenue, Mohawk 4-5800

CLEVELAND 13, OHIO – J S Wenger, 55 Public Square, Superior 1-7000

DALLAS 1, TEXAS – E E Schirmer, The Vaughn Building, Prospect 5064

DENVER 2, COLO. – J W Patten, U. S. National Bank Building, 1740 Broadway, Alpine 5-2981

DETROIT 26, MICH. – L W Romigh, 856 Penobscot Building, Woodward 2-1793

LOS ANGELES 17, CALIF. – Gene Fruhling, 1125 West Sixth Street, Madison 6-9351

NEW YORK 36, N. Y. – W R Klein and J E Dean, 500 Fifth Avenue, Oxford 5-5959

PHILADELPHIA 3, PA. – C R Long, Architects Building, 17th and Sansom Streets, Rittenhouse 6-0670

PITTSBURGH 22, PA. – J S Wenger, 1111 Oliver Building, Atlantic 1-4705

ST. LOUIS 8, MO. – G L Crane, Continental Building, 3615 Olive Street, Jefferson 5-4867

SAN FRANCISCO 4, CALIF. – R C Alcorn, 68 Post Street, Douglas 2-4600

LONDON E.C. 4, ENGLAND – B H Butler, McGraw-Hill Company Ltd, 95 Farringdon Street

W K PONDER — *Circulation Manager*

speaking of **Power**

Nondestructive testing, theme of this issue's special report, is now cutting a telling swath across the field of plant maintenance. Well over a year ago, Associate Editor Steve Elonka proposed NDT for special report treatment, forecasting it would become a hot advance on the maintenance front. It has.

Industry is fast looking upon NDT as a maintenance procedure; as an extension of the initial tests used by the equipment maker during manufacture; NDT from cradle to grave, if you will. Whether you think in terms of the huge Allis-Chalmers rig for X-ray piercing of steel 20-in. thick to look inside a valve casting . . . or the newish highly sensitive ultrasonic-testing transducer developed by Branson Instruments, Inc for working with lead and laminated plastics, the ultimate aim is precisely the same: to study that which you can't see with the naked eye and without harming the finished material.

This latter joint goal is in sharp contrast to results attained in using any of the well-known destructive testing techniques. Here the only point proven is simply that the single piece of equipment being tested failed at a certain load, pressure, temperature, stress, shear, etc.

Checking report's accuracy took a big chunk out of Steve's time budget. The first check came when the initial draft rolled off his typewriter. At that time copies were sent to top men in the field on the recommendation of Phil Johnson, Secretary of the Society for Nondestructive Testing, Inc.

With these comments in hand, Steve worked up the text for the printshop. When first proofs rolled off the press, Johnson again volunteered the technical help of the Society's membership, and a second pass was made at checking facts. Again critiques were thrown at Steve who again had the job of separating opinionated comments from those concerned solely with facts. When the final job was "put to bed," we knew that every practical step had been taken to insure accuracy. If you receive the Journal of the Society for NDT, look for a reprint of Steve's report in the May-June issue.

Lon Lowley

POWER (with which are consolidated *Science and Industry, The Engineer Review, The Engineer, The Stationary Engineer* and *Operating Engineer*) is published monthly by McGraw-Hill Publishing Company, Inc, James H McGraw (1860-1948), Founder. PUBLICATION OFFICE: McGRAW-HILL BUILDING, 330 W 42nd St, New York 36, N. Y. See panel below for directions regarding subscriptions or change of address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W 42nd St, New York 36, N. Y. Donald C McGraw, President; Joseph A Gerardi, Executive Vice-President; L Keith Goodrich, Vice-President and Treasurer; John J Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B Smith, Vice-President and Editorial Director; Joseph H Allen, Vice-President and Director of Advertising Sales; A R Venezian, Vice-President and Circulation Coordinator.

Subscriptions are solicited only from executives, engineers and supervisory personnel engaged in design, operation and maintenance of power, light, heat and other plant services in utilities, construction firms, industrial and service plants. **Position and company connection must be indicated on subscription orders. Send to address shown in box below.**

United States subscription rate for individuals in the field of the publication $5.00 per year, single copies $1.00, unless otherwise indicated. Canada: $7.00 for one year. Foreign: $15.00 for one year. Second-class mail privileges authorized at New York, N. Y. Printed in U.S.A. Title registered in U.S. Patent Office. ©. Copyrighted 1958 McGraw-Hill Publishing Company, Inc, all rights reserved.

Power articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index, obtainable on request to the Editor. Notice of availability appears in POWER.

SUBSCRIPTIONS: Send subscription correspondence and change of address to Subscription Manager, POWER, 330 W 42nd St, New York 36, N. Y. Subscribers should notify publisher promptly of any change of address, giving old as well as new address, and including postal zone number, if any. If possible, enclose an address label from a recent issue of the magazine. Please allow one month for change to become effective.

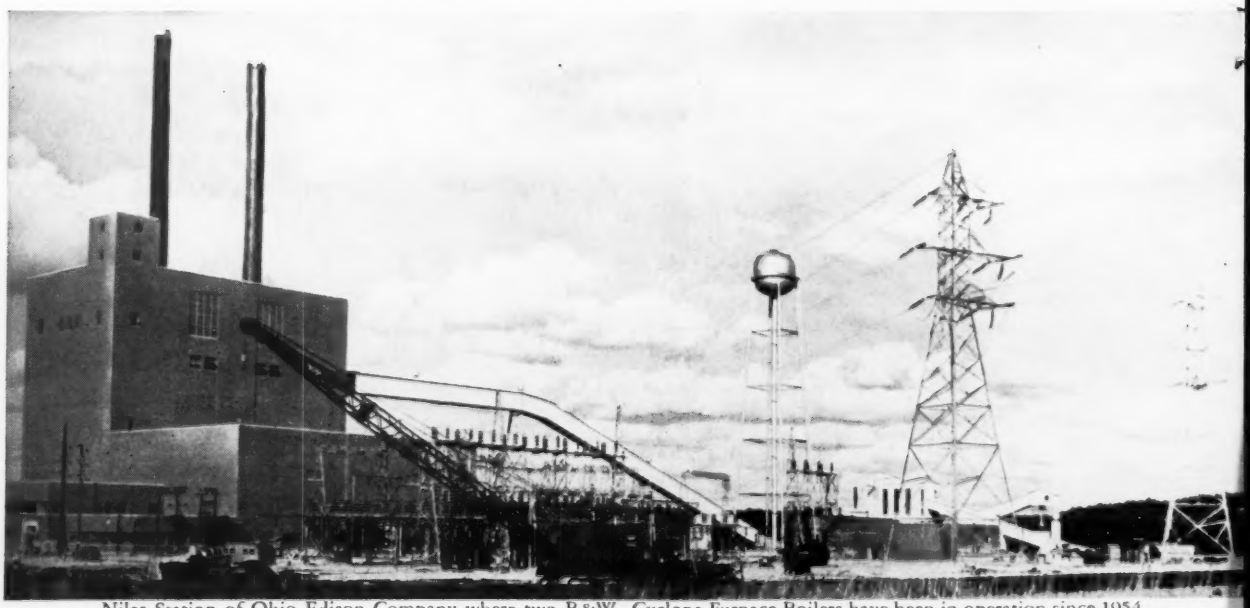
Postmaster: Send form 3579 to POWER, 330 W 42nd St, N. Y. 36, N. Y.

HOW THESE INSTALLATIONS

Jersey Central Power & Light Company's E. H. Werner Station. Here the success of the B&W Cyclone Furnace Boiler, the first installed in the East, has led to the purchase of two more boilers.

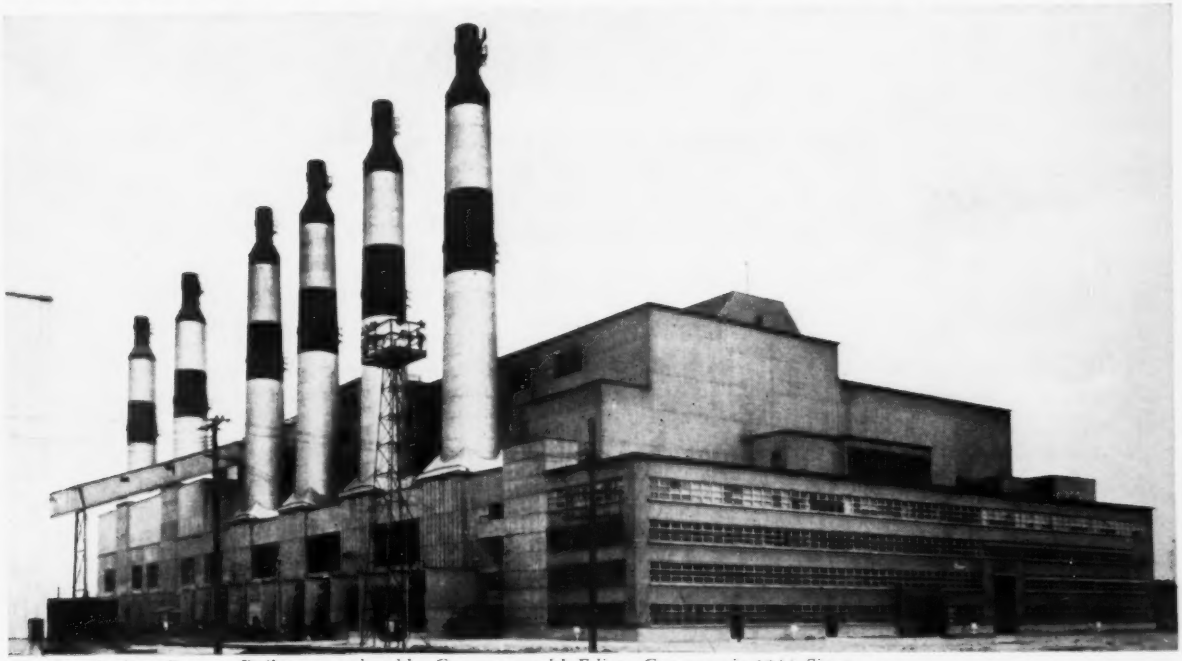
The B&W Cyclone Furnace...

A Modern, Economical Way to Burn Fuel for Power



Niles Station of Ohio Edison Company where two B&W Cyclone Furnace Boilers have been in operation since 1954.

UTILIZE LOW-GRADE FUELS



The first Cyclone Furnace Boiler was ordered by Commonwealth Edison Company in 1944. Since then this utility has purchased 15 more units, six of them for the Ridgeland Station shown here.

The B&W Cyclone Furnace simplifies the entire process of coal preparation, combustion, ash handling and ash segregation. Its cost-saving quality contributes to lower fuel costs and reduced maintenance as well as increased operational simplicity, flexibility and safety.

Although the B&W Cyclone Furnace operates simply and dependably on either oil or gas, it is particularly effective in utilizing inexpensive, low-grade coals. Its rapid combustion burns the coal more completely and operates with low excess air. Most of the ash is melted to slag right in the Cyclone Furnace, where it is easy to handle and dispose of. The slag cleaning and fly-ash problems so prevalent with other types of firing are consequently alleviated.

Many other modern advances in combustion and high-pressure, high-temperature steam generation are available through B&W. Write for further information today. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

G-882

BABCOCK & WILCOX

BOILER DIVISION

PURCHASERS OF THE B&W CYCLONE FURNACE

FOR CENTRAL POWER STATIONS	Number of Cyclone Furnace Boilers
Atlantic City Electric Co.	1
Baltimore Gas & Electric Co.	1
Chilena de Electricidad	2
Columbus & Southern Ohio Electric Co.	2
Commonwealth Edison Co.	16
Consumers Public Power District (Nebraska)	1
Detroit Edison Co.	1
Indiana & Michigan Electric Co.	1
Jersey Central Power & Light Co.	3
Memphis Light, Gas & Water Division	3
Middle South Utilities, Inc.	1
Missouri Public Service Co.	1
Monongahela Power Co.	1
Northern Indiana Public Service Co.	3
Ohio Edison Co.	2
Ohio Power Co.	6
Public Service Co., of New Hampshire	1
Tampa Electric Co.	3
United Illuminating Co.	2
Wisconsin Power & Light Co.	4
FOR INDUSTRIAL INSTALLATIONS	
American Cyanamid Co.	1
American Enka Corp.	1
Columbia Southern Chemical Co.	1
Consolidated Water Power & Paper Co.	1
Dow Chemical Co.	5
Eastman Kodak Co.	1
Greenwood Mills	1
International Paper Co.	4
National Container Corp., of Wisconsin	1
Rhinelander Paper Co.	1
St. Croix Paper Co.	1
Thilmany Pulp & Paper Co.	1
West Virginia Pulp & Paper Co.	1
Total	**75**

IMPROVED BLOWER NOZZLE and

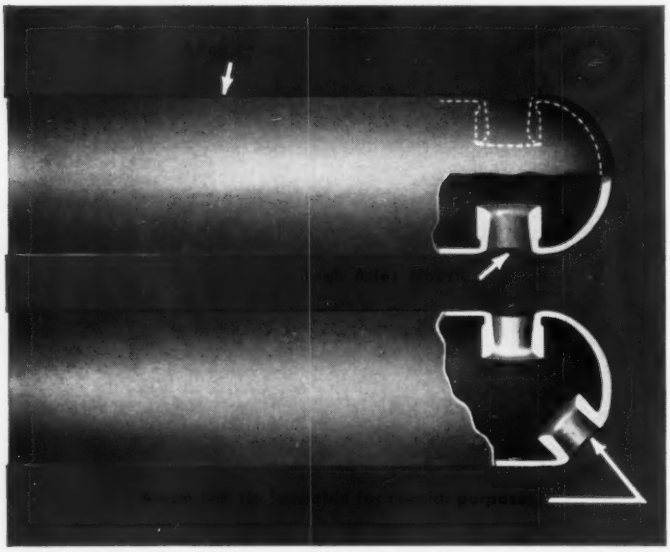
more important features of the

New Diamond Series 300 IK
LONG RETRACTING BLOWER

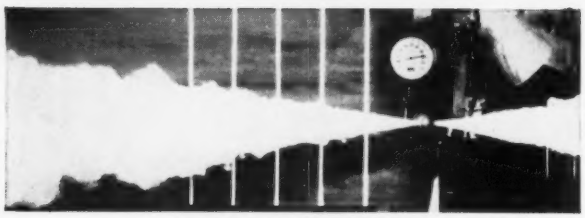
This improved nozzle provides more available cleaning energy per pound of steam or compressed air. A modified venturi, it is the result of extensive research during which more than 50 contours were tested.

The positively-controlled, close helical cleaning pattern assures optimum coverage of the heating surface. Return travel path is exactly intermediate to forward travel path . . . resulting in a positive nozzle sweep every inch.

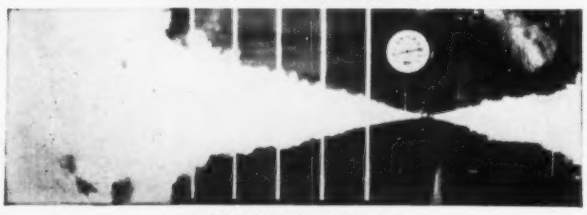
These features are two of many reasons why the Diamond Series 300 IK Blower does a better and more economical job of cleaning surfaces which require a long retracting blower. Other advantages are listed at the bottom of the opposite page. Ask the nearest Diamond office for Bulletin 2111U which will tell you much more about the new Series 300 IK.



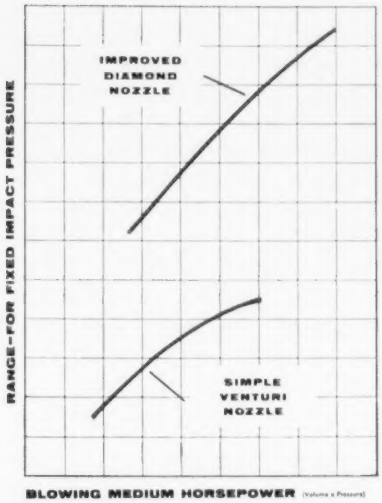
Improved Diamond Type "A" Nozzle has low approach velocity for optimum nozzle performance (see curves below). It provides greatest impact for any given blowing pressure . . . means greater effectiveness and economy.



IMPROVED DIAMOND NOZZLE

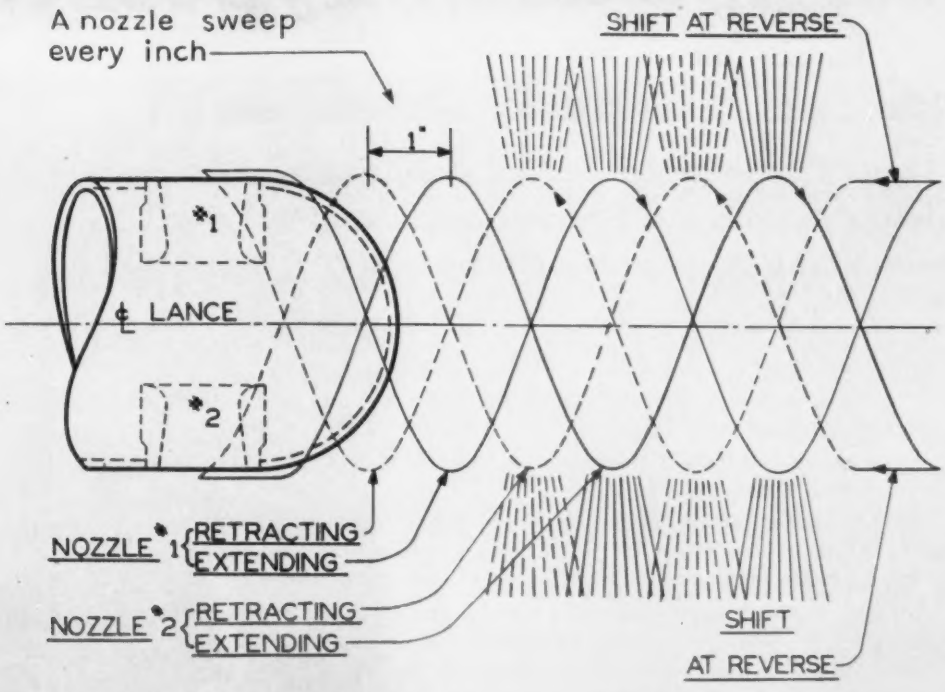


7818 SIMPLE VENTURI NOZZLE



Note the greater blowing range of the improved Diamond Nozzle when compared with a simple venturi nozzle under identical test conditions.

IMPROVED CLEANING PATTERN



Nozzle-sweep-every-inch blowing pattern assures COMPLETE coverage of ALL surface EVERY time

DIAMOND POWER SPECIALTY CORPORATION

LANCASTER, OHIO

Diamond Specialty Limited
Windsor, Ontario

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Backbone and Protective Cover
- Front End Single-Motor Drive
- Compact, Accessible Electric Power and Control Terminal Facilities
- Positive Gear Carriage Drive
- Poppet Valve with Adjustable Pressure Control
- Positive Mechanically Operated Valve
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

ALLIS-CHALMERS STEAM TURBINE-GENERATOR UNITS

4 Basic Types for

Select from Condensing . . . Non-Condensing . . . Condensing Automatic Extraction . . . and Non-Condensing Automatic Extraction Types

ALLIS-CHALMERS WA-Series steam turbine-generator units are built in NEMA ratings from 2000 through 10,000 kw, and AIEE-ASME preferred standard ratings up to and including 16,500 kw.

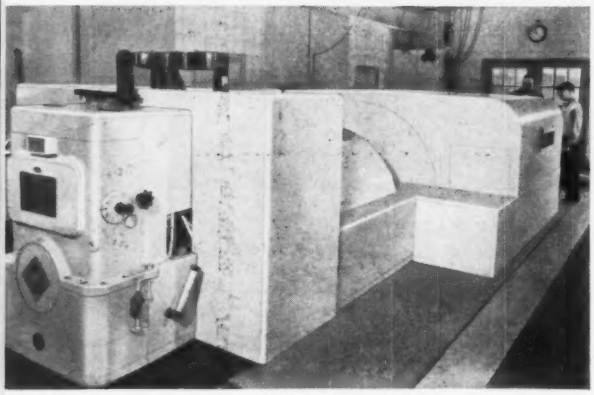
Both utility and industrial service requirements can be filled from this broad line of modern machines.

Turbine, generator and exciter are carefully engineered to operate as a unit. Oil piping and generator gas coolers are located above the floor line to eliminate trenching and duct-work . . . facilitate installation.

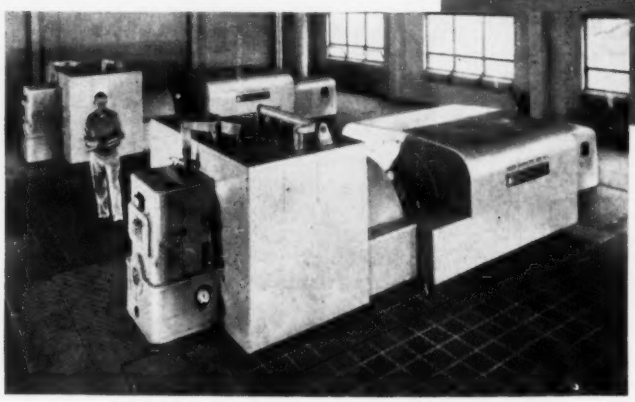
Other features include a self-contained lubrication system, metallic labyrinth-type steam seals, and unit shipment of assembled machine.

For detailed information and help in selecting the type and size unit for your requirements — from 2000 to 500,000 kw, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wis.

Condensing — This 16,500-kw steam turbine-generator is hydrogen cooled, and is typical of the largest WA-Series units.



Non-Condensing — Power and process steam for a paper manufacturer are supplied by this Allis-Chalmers 4000-kw unit.



Non-Condensing Automatic Extraction — These two 3000-kw units in power plant of hospital provide by-product power. Process steam is used for laundry, cooking, heating, and sterilizing.

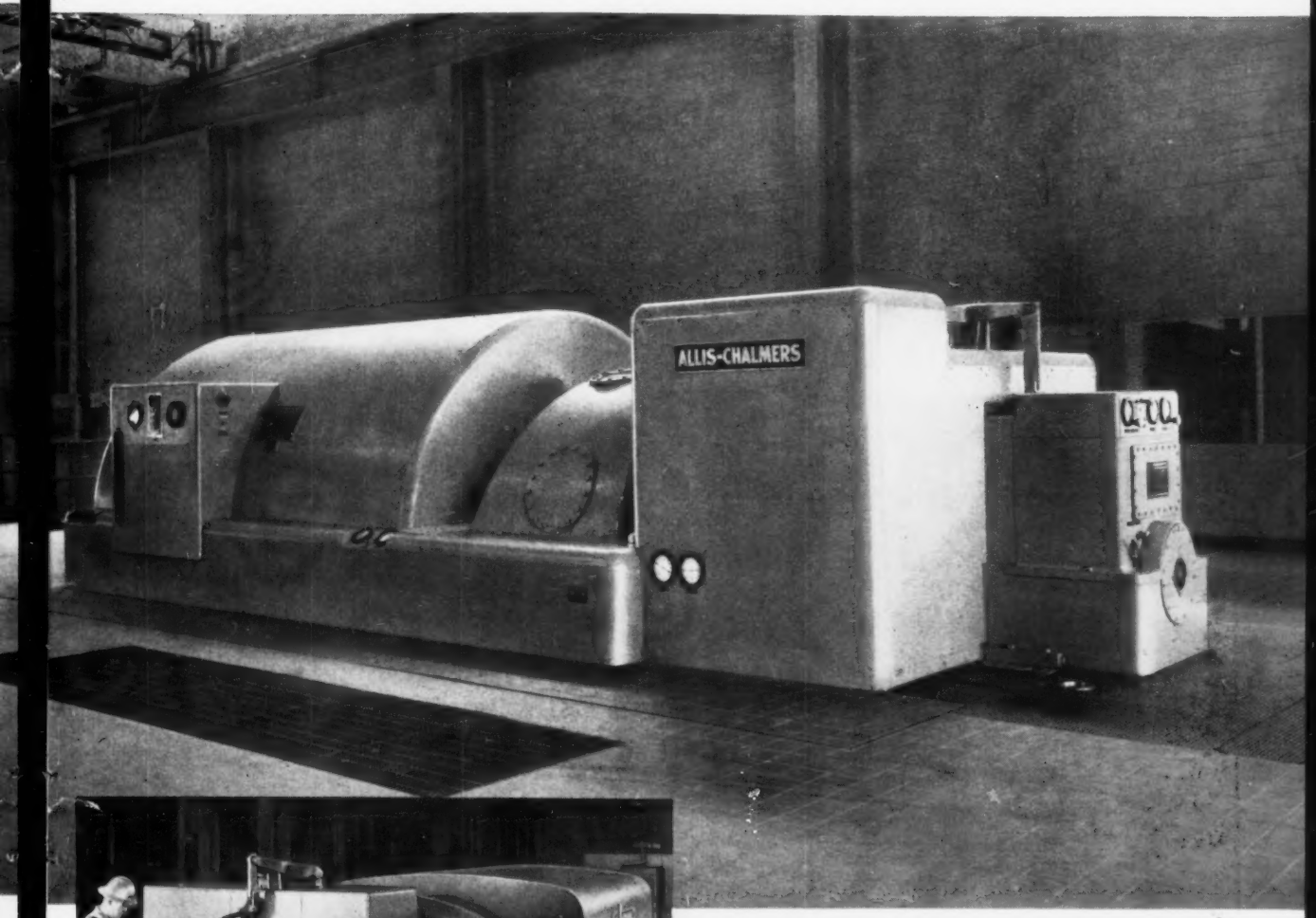
A-C ALLIS-CHALMERS

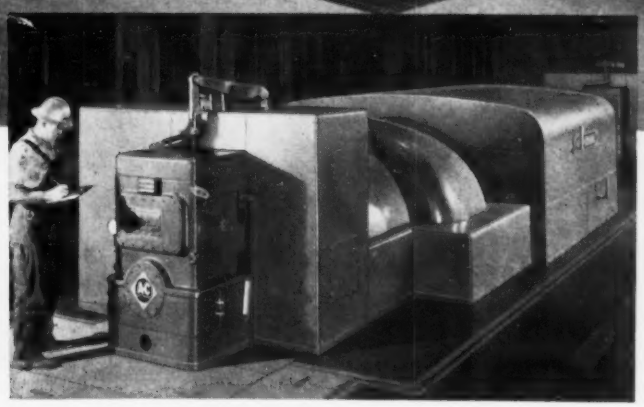
ALLIS-

A-5666

2000 to 16,500 Kw

Modern Power Plants

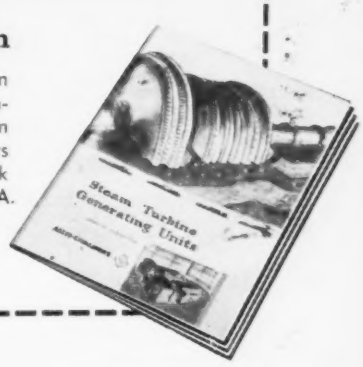




Condensing Automatic Extraction — Power is generated as a by-product of process steam needs at this chemical company. Two 5000-kw Allis-Chalmers steam turbine-generators are used.

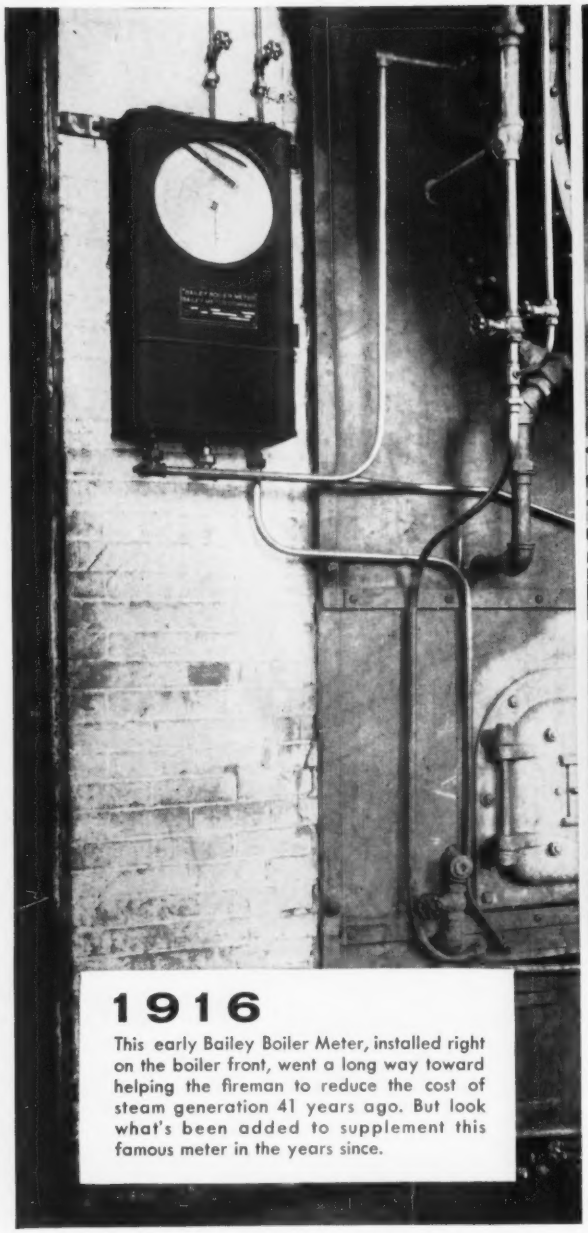
New Bulletin

New 40-page bulletin provides detailed engineering information about Allis-Chalmers WA-Series units. Ask for Bulletin 03B7654A.



CHALMERS

Bailey's pattern for 41 more



1916

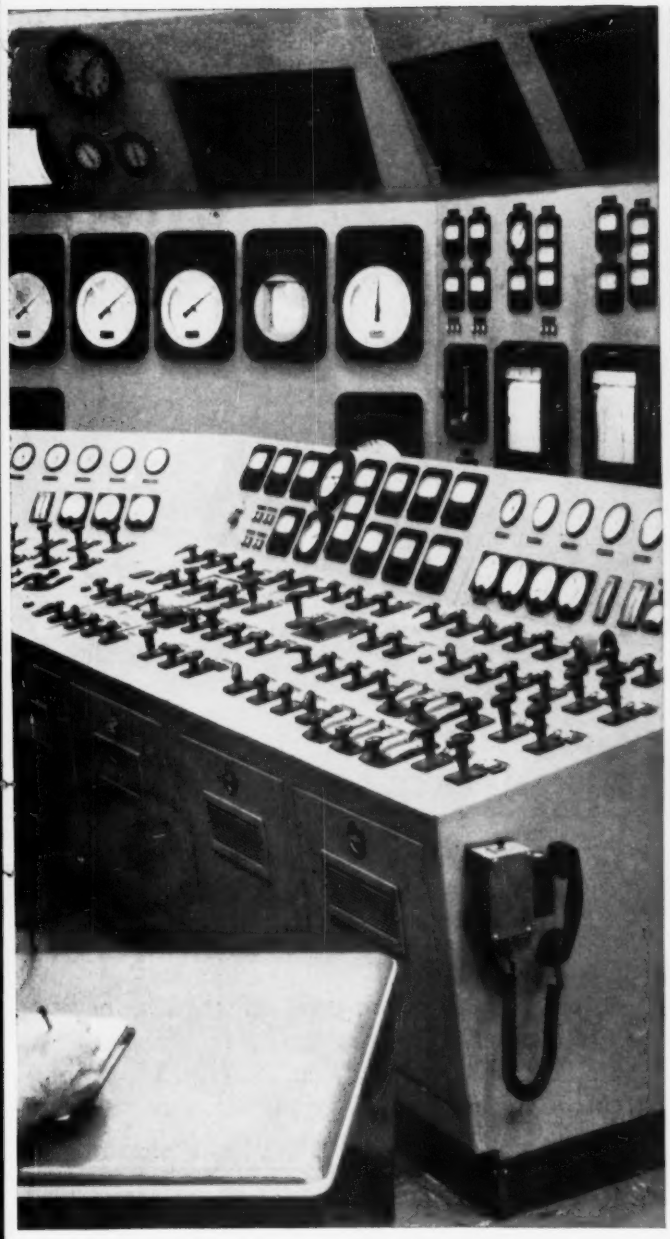
This early Bailey Boiler Meter, installed right on the boiler front, went a long way toward helping the fireman to reduce the cost of steam generation 41 years ago. But look what's been added to supplement this famous meter in the years since.

TODAY

Bailey leads the way in compatible pneumatic and electric measuring, transmitting, recording and control equipment. Thousands of successful installations are living proof of Bailey progress . . . in control engineering . . . in modern application technique.

BAILEY METERS

years of control progress



TOMORROW

New and even more amazing measuring and control techniques, such as Bailey's Performance Monitoring and Scanning Equipment, will be used. The Bailey pattern for progress is your assurance of the finest in instruments and controls . . . now and in the future.

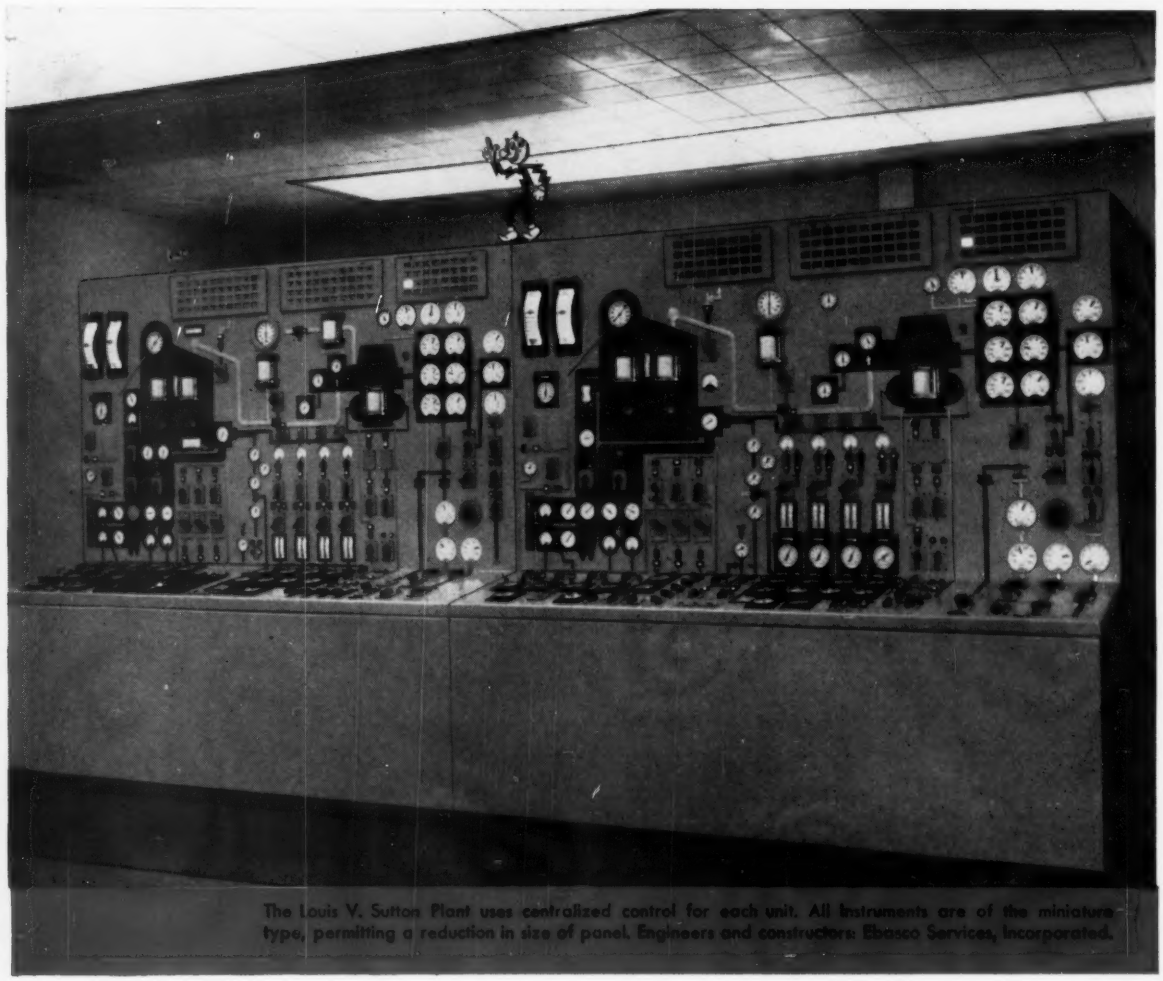
A134-2

Instruments and controls for power and process

BAILEY METER COMPANY

1036 IVANHOE ROAD • CLEVELAND 10, OHIO

In Canada—Bailey Meter Company Limited, Montreal



The Louis V. Sutton Plant uses centralized control for each unit. All instruments are of the miniature type, permitting a reduction in size of panel. Engineers and constructors: Ebasco Services, Incorporated.

It's Copes-Vulcan Combustion Control at Louis V. Sutton Plant!

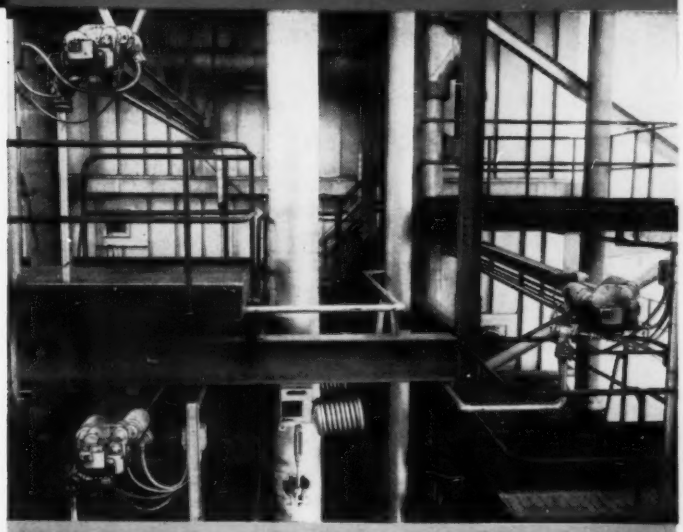
Units 1 and 2 in the Louis V. Sutton Steam-Electric Generating Plant of Carolina Power & Light Company are equipped with Copes-Vulcan combustion control. This modern system features simplicity of circuit design, with independent control loops on air flow, fuel loading and furnace draft. Interconnection of the control loops is eliminated because of the speedy response of each of the components.

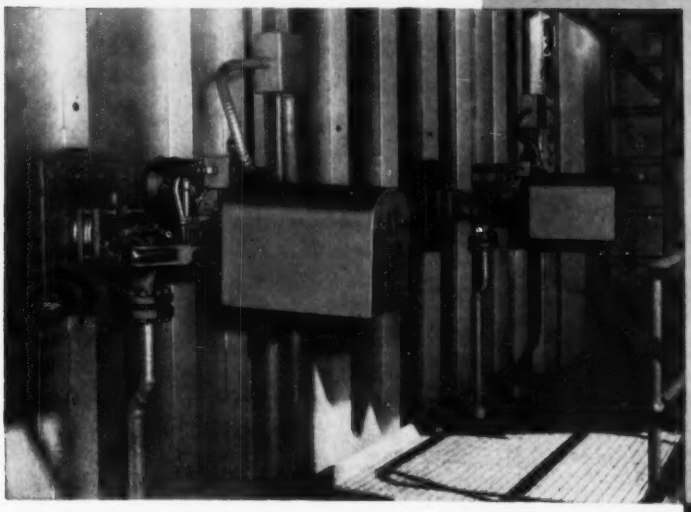
Station and controller design facilitates remote switching from automatic to manual, or manual to automatic. Variations in circuit design would provide for shortening tubing runs between controllers and drive units, valves or other controlling devices, should transmission lines become excessively long.

Modern Copes-Vulcan combustion control systems offer many advantages that will help you reduce production costs. In addition, from this one dependable source, you can get a fully integrated system including feed water control, boiler feed pump recirculation control, steam temperature control and automatic soot blowing. Your Copes-Vulcan representative has the ideas, information and experience to help you choose the system best suited to your needs.

C-V NEWS NOTES

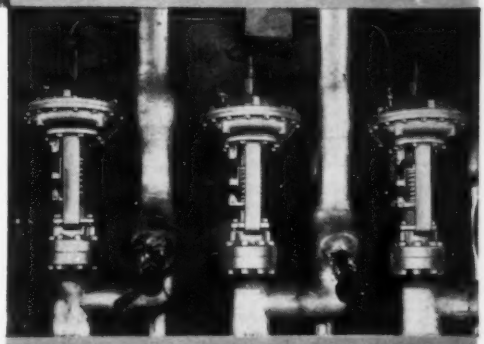
For a complete description of the Sutton Plant control system, see your Copes-Vulcan representative, or write the factory for Bulletin 1032.





Vulcan long retractable soot blowers are installed on Units 1 and 2. Both soot blowing systems feature automatic-sequential control.

Copes-Vulcan RW-2E wall de-slaggers on Unit 2 have dual-motor electric drive. One motor extends and retracts the lance, the other rotates the nozzle.



Copes-Vulcan boiler feed pump recirculation valves on Units 1 and 2 open automatically when water flow falls below a pre-determined minimum. When flow reaches a predetermined maximum controller closes the valve.

COPES VULCAN

BLAW-KNOX

COPES-VULCAN DIVISION

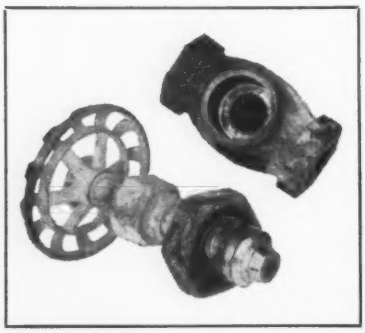
BLAW-KNOX COMPANY

ERIE 4, PENNSYLVANIA

"I got 5 years of service from a valve I expected to last only 90 days"

Mr. C. L. Worthington, Chief Engineer for E. L. Bruce Co., Little Rock, Arkansas plant, standing near a Walworth No. 225P Bronze Globe Valve with "500 Brinell" stainless steel seats and discs that was installed in severe boiler blowdown service. Hardened seats and discs are especially resistant to wire drawing, steam cutting, or galling.

Some time ago Mr. C. L. Worthington, Chief Engineer for E. L. Bruce Co. plant at Little Rock, Arkansas, was having valve trouble on some newly installed boilers. The first boiler to go in service generated 600 hp operating at 200-pounds pressure. The water was so bad that a hot lime and soda ash water softener treatment had to be used, and it was necessary to add other chemicals to this solution from time to time. Mr. Worthington wanted to use a continuous blowdown to skim off the worst part of the scum on the water. He installed a small blow pipe about an inch below the normal water level in the boiler. This worked well, except that the one-inch valve on the line could only be partially opened and let a small part of the scum be blown off at one time. If the valve was widely opened, it would not take long to lower the water level in the boiler and run the steam pressure down. This service gave Mr. Worthington lots of valve trouble, as can well be imagined, because of the extreme wire drawing that occurred.



A Walworth No. 225P Bronze Globe Valve that gave perfect performance for four years and 362 days in a severe boiler blowdown service where the Chief Engineer said he had never been able to keep a valve more than 60 to 90 days.

One day the Walworth representatives in that area, called upon Mr. Worthington and demonstrated the outstanding features of the Walworth No. 225P Bronze Globe Valve. This valve, which has a working steam pressure rating of 350-pounds at 550°F, has a plug-type stainless seat and disc which has been heat treated to a minimum hardness of 500 Brinell. After listening to the Walworth men and examining a 225P valve, Mr. Worthington agreed that he would try one in the severe service described. He said if it lasted 90 days, he would consider that it had done a good job.

The valve went into service and came out within three days of being in service five years under very severe operating conditions. The valve was used 24 hours a day from early in the morning on Monday until Saturday night, when it was closed until the following Monday morning. It was never opened more than three-quarters of a turn, and most of the time it was opened only one-half to one-quarter of a turn. For the life of the valve, nearly five years, it never failed to give a 100% closure when shut on Saturday night until opened Monday morning.

When another 600 hp 200-pound pressure boiler went into service, it also was equipped with a one-inch Walworth No. 225P Bronze Globe Valve on the same service.

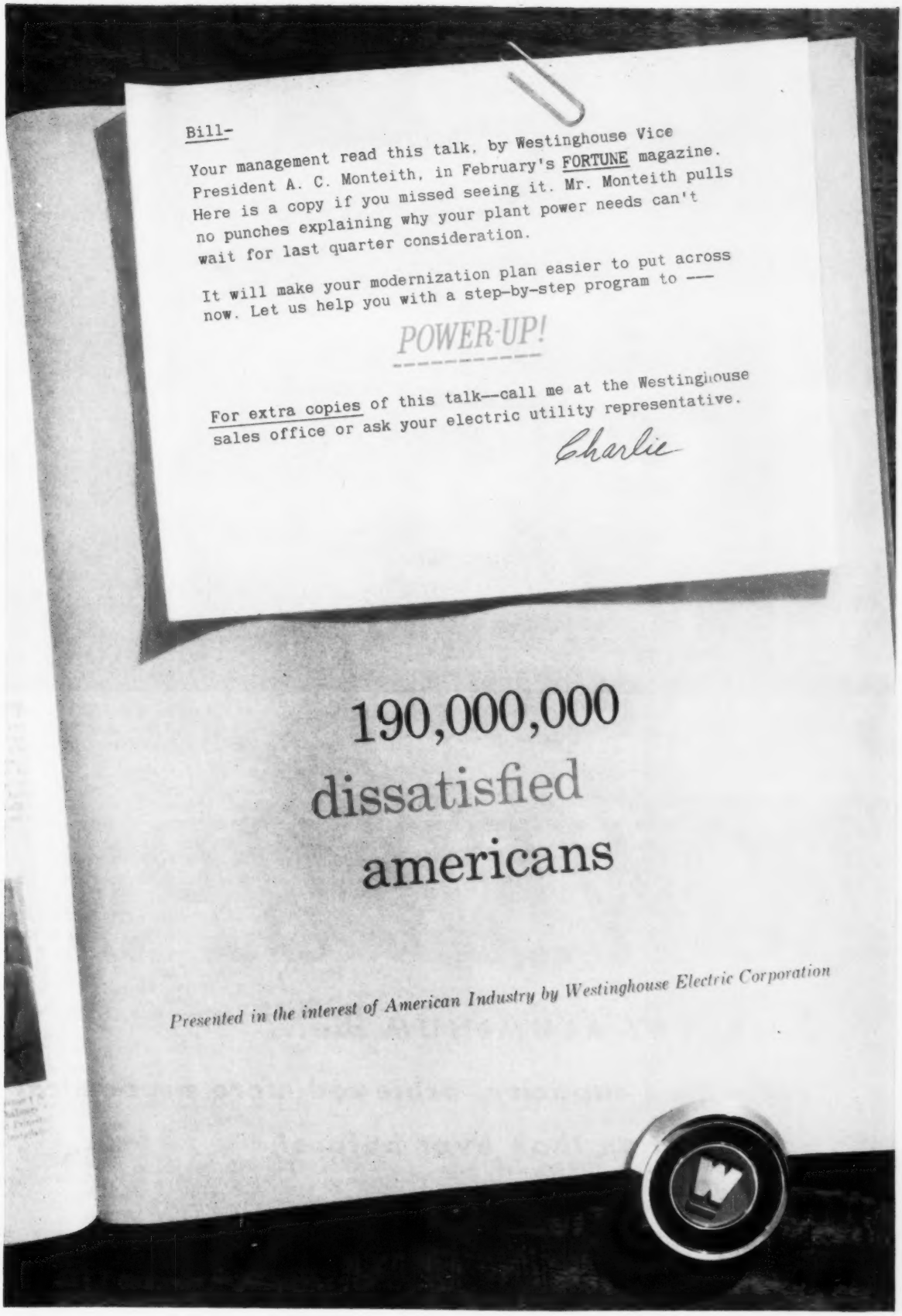
In view of the severe service and the wire drawing to which this valve was subjected, it is interesting to note that the original valve (which was taken out of service almost five years after it had been installed) was removed – not because the seat and disc were wire drawn – but because the turbulence of the steam had finally caused a small hole to occur in the wall of the body of the valve. Needless to say, the valve that was taken out of service was replaced immediately by another one-inch Walworth No. 225P Bronze Globe Valve, positive assurance that Mr. Worthington is satisfied that this valve has "done a good job."

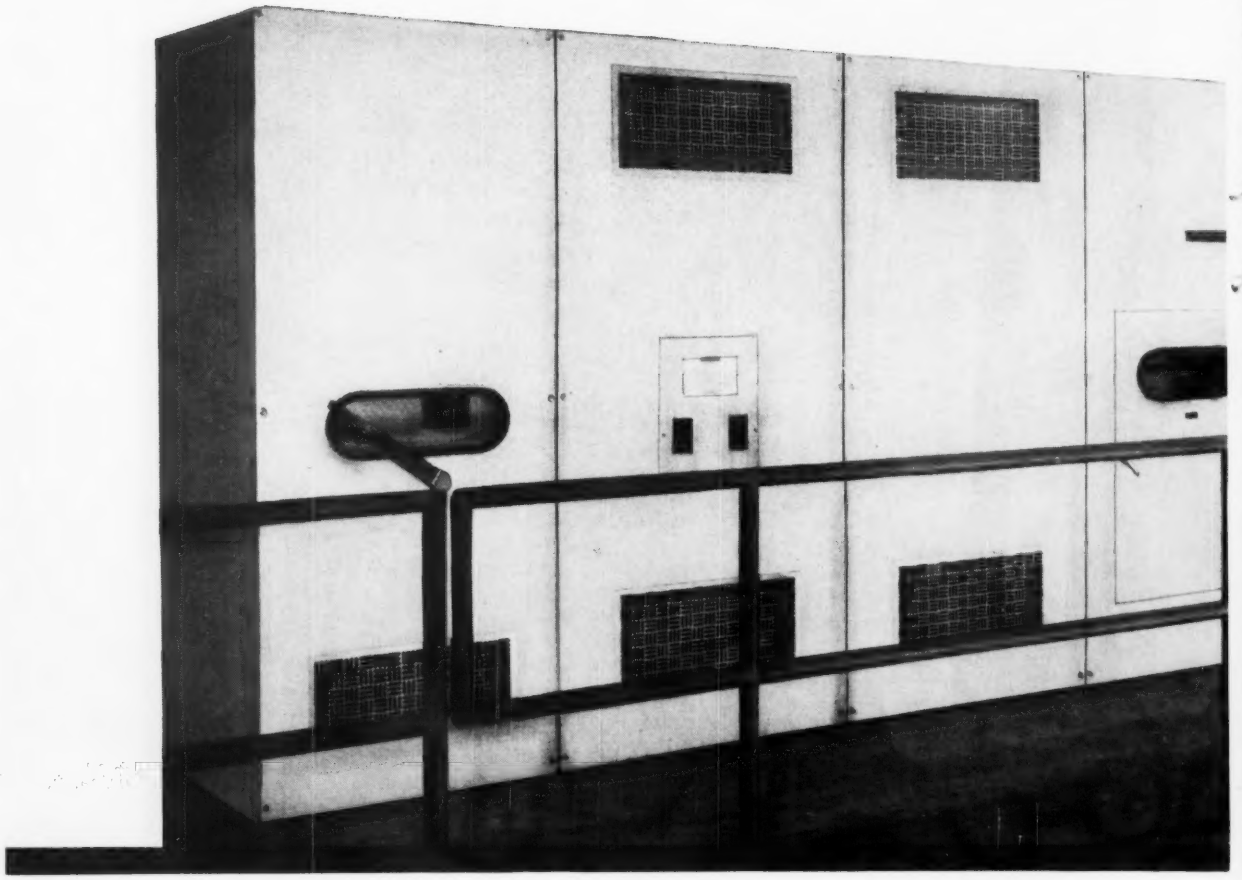
Other Walworth products include complete lines of Gate, Globe, Angle, Check and Lubricated Plug Valves in bronze, iron, steel, stainless steel and special alloys. Complete information and literature will be furnished upon request.

WALWORTH

60 East 42nd Street, New York 17, New York

SUBSIDIARIES: ALOYCO ALLOY STEEL PRODUCTS CO. CONOFLOW CORPORATION GROVE VALVE & REGULATOR CO. SW SOUTHWEST FABRICATING & WELDING CO., INC. MH M & H VALVE & FITTINGS CO. WALWORTH COMPANY OF CANADA, LTD.

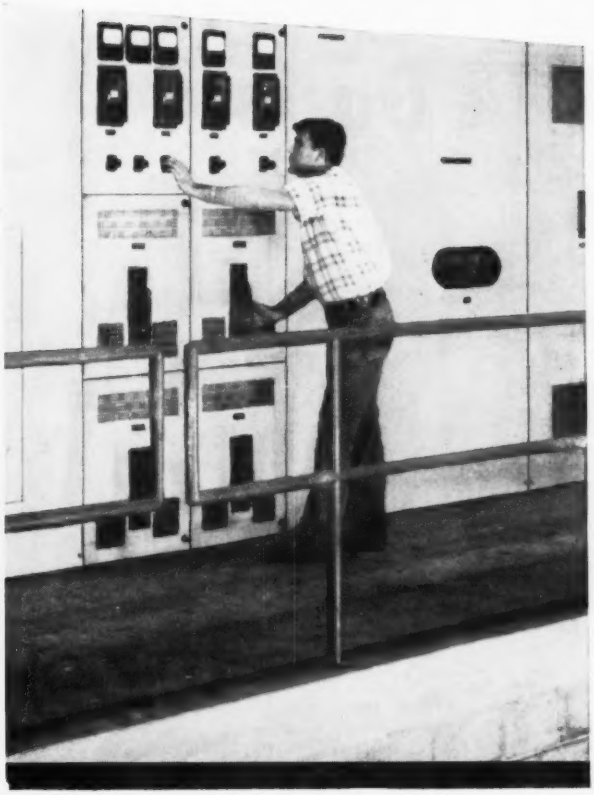

Bill-
Your management read this talk, by Westinghouse Vice President A. C. Monteith, in February's FORTUNE magazine. Here is a copy if you missed seeing it. Mr. Monteith pulls no punches explaining why your plant power needs can't wait for last quarter consideration.
It will make your modernization plan easier to put across now. Let us help you with a step-by-step program to ---
POWER-UP!
For extra copies of this talk—call me at the Westinghouse sales office or ask your electric utility representative.
Charlie
190,000,000
dissatisfied
americans
Presented in the interest of American Industry by Westinghouse Electric Corporation



POWER-UP!

HARVEY ALUMINUM *did...*

doubled capacity, achieved more economical production than ever before!



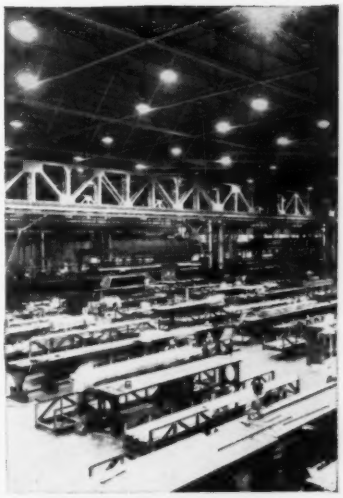
Seven Westinghouse spot network power centers located in major production areas supply motor loads, induction and resistance-type furnaces and the mercury lighting system.

Harvey Aluminum doubled productive capacity and cut per-pound production costs as well. Their large-scale expansion program had called for extrusions of unprecedented weight and dimensions. Investigation proved that flexible high-voltage electrical distribution was the primary power requirement. Two incoming circuits at 13.8 kv established primary voltage. A spot network system, comprised of seven load centers, was installed at major load points and serves equipment throughout the plant through low-impedance and plug-in bus duct. This basic system is ideal for unbalanced and shifting furnace-heating loads.

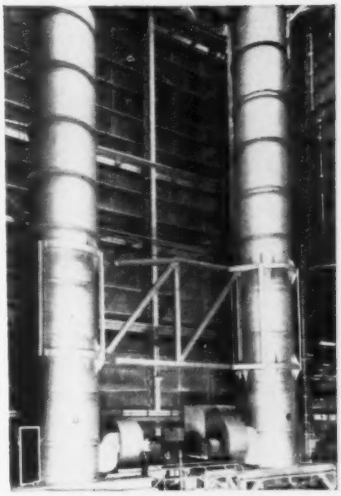
Service continuity is assured, and voltage regulation has measurably improved. Future relocation of machinery and unpredictable changes of equipment, too, have been provided for. This high order of electrical planning has helped maintain Harvey's position as one of the world's lowest cost producers of fabricated aluminum.

Is yours a problem of production changeover, new products, or rising costs and a profit squeeze? Your electric utility sales engineer or your Westinghouse representative can help you with a practical solution . . . Power-Up!

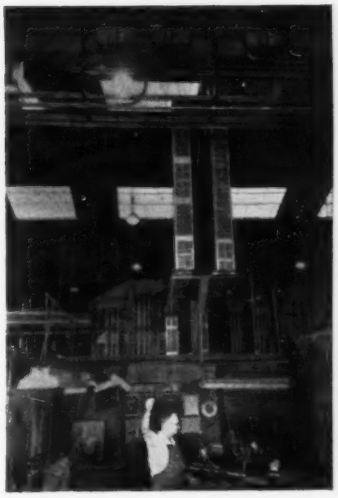
J-97218-A



"The Westinghouse 480-v color-corrected mercury-vapor lighting system is remarkably superior to conventional lighting," says Mr. Lawrence Harvey, Executive Vice President. "It is not only less expensive to operate at the same level of illumination, but replacement and maintenance costs are reduced."



Twin 110' Westinghouse electric furnaces are powered by a specially engineered system providing for cyclical furnace loads, and at the same time, making maximum use of network capacity.

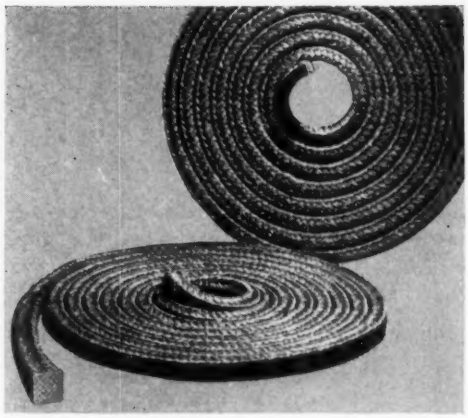


Westinghouse bus duct, carrying power throughout the plant, is another key to distribution system flexibility. Here, two runs of ventilated low-impedance duct from the transformer feed individual branch runs of 1000-amp plug-in duct.

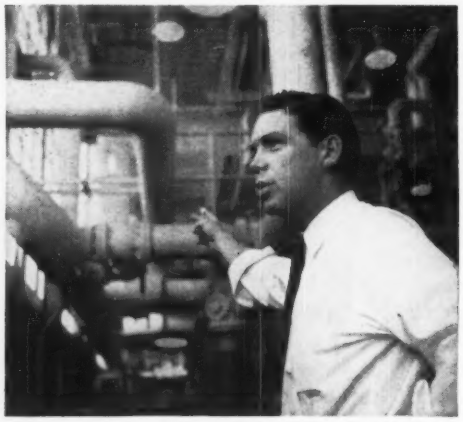
YOU CAN BE SURE...IF IT'S Westinghouse

How power engineers 4 Garlock

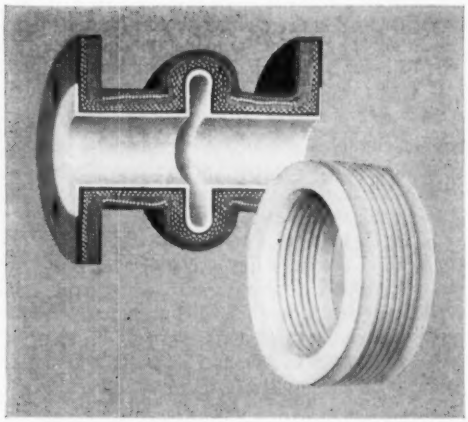
"...the new TEFLON* Fiber Packings (especially those in the LATTICE BRAID** form) give excellent life on pumps handling difficult fluids. In the first place, they are chemically inert and tough. But beyond that, Garlock has made an extremely resilient, flexible product in this TEFLON LATTICE BRAID. Just the thing for sealing shafts rotating at high speeds. You get cooler pump operation as well as good sealing characteristics."



Garlock LATTICE BRAID Packing made from pure TEFLON yarn. Write for Catalog AD-131.



"...TEFLON expansion joints should be used to absorb shock, vibration, expansion, and contraction of costly corrosion resistant piping. For low pressure systems handling foods, acids, caustics, etc., Garlock makes an all-TEFLON Expansion Joint which is ideal. For systems under higher pressures the reinforced rubber expansion joint with TEFLON liner is more suitable."



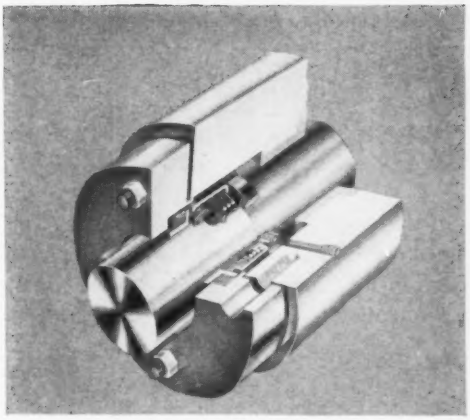
Garlock Teflon and TEFLON-lined Expansion Joints. Write for Catalog AD-137.

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

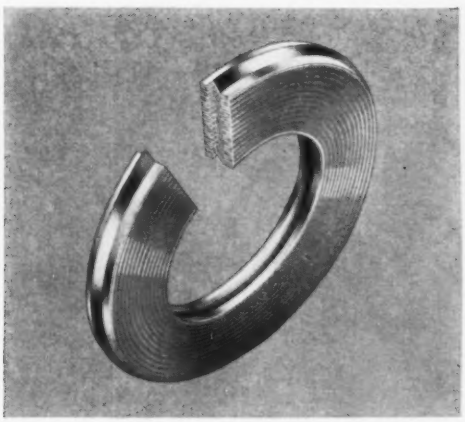
speak about these products

". . . of course, the ultimate in sealing today is the mechanical seal. In many applications Garlock's MECHANIPAK** Seals operate indefinitely. Difficult sealing jobs, however, are the real test of a mechanical seal—and MECHANIPAKS have provided a long and still growing list of successful applications against water, oils, alcohol, mild acids, and solvents. By making use of TEFLON, Garlock has also developed a CHEMISEAL** mechanical seal with the greatest immunity to corrosion and contamination."



Garlock MECHANIPAK Seal. Write for Catalog AD-150 and AD-164.

". . . Garlock Spiral Wound GUARDIAN** Gaskets are designed for various pressure ranges under established bolt loads. This is done by increasing or decreasing the number of layers, or windings, of stainless steel and TEFLON (or asbestos). Thus, a safe seal is obtained at highest pressures.



Garlock Spiral Wound GUARDIAN Gasket. Write for Catalog AD-104.

These products are another important part of the Garlock 2,000 . . . two thousand styles of Packings, Gaskets, and Seals for every need. The only complete line. It's one reason you get unbiased recommendations from your Garlock representative. Call him or write for literature.

THE GARLOCK PACKING COMPANY, PALMYRA, N.Y.

For Prompt Service contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

*DuPont Company Trademark
**Registered Trademark

In the last two years...

All These Improvements

Whether your fly ash problems require a straight precipitator, a combination unit, or a mechanical collector alone, you can count on an economical solution from Research-Cottrell.

1. New Cyclo-trell—Sets new standards for collection efficiency and gas volume capacity. Double deck arrangement improves gas distribution to precipitator and conserves valuable space. Collecting tube is erosion resistant.

Cottrell Automation System—Higher "around-the-clock" collection efficiency, without manual adjustments. New electronic methods provide continuous optimum energization.

2. Opzel Collecting Electrodes—New design cuts cost, provides optimum precipitation zone with better gas flow and electrical conditions.

3. New Discharge Electrode Rappers—Available in air, electric, vibrating or impact type. Cycle and intensity are easily adjusted to maintain highest collection efficiency.

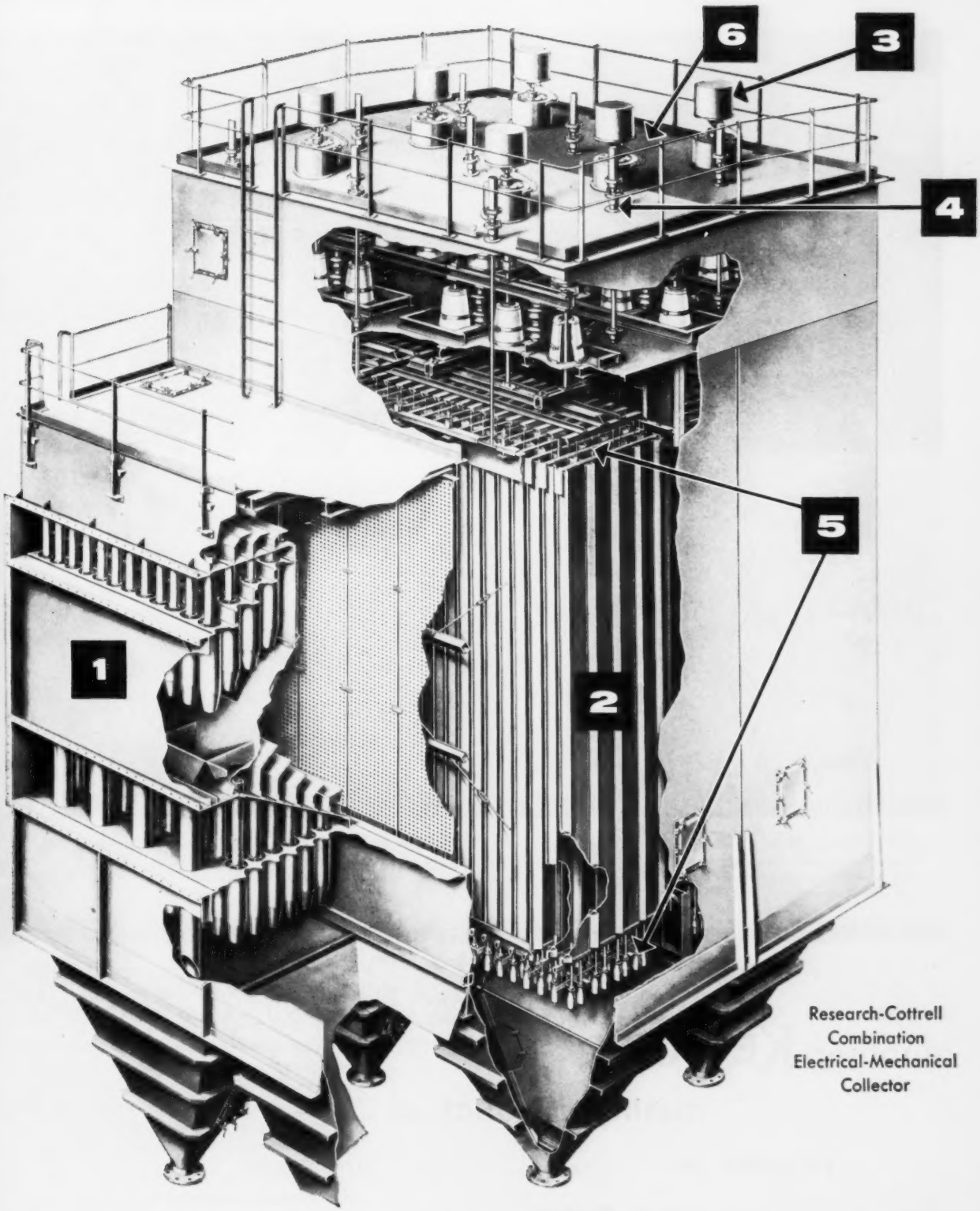
Silicon Rectifiers—New, hermetically sealed rectifiers last as long as the precipitator—without maintenance. Rectification efficiency is 96% to 99% with no voltage drop due to age.

4. M. I. Rappers on Roof—New arrangement provides better rapping and easier access to automatically controlled rappers, without additional expensive platforms.

5. New Discharge Electrodes—No. 430 stainless steel discharge electrodes are individually hung for easier access from top to bottom. Entire collecting plate surface is effective because the discharge wires extend well beyond the top and bottom of the plate.

6. New Top Constructions—Insulator compartments or steel housing over the entire roof are available. Designed for low insulator maintenance; bushings can be replaced without disturbing high tension frame. Top housing provides "out-of-weather" working space for maintenance.

RC-179.



Research-Cottrell
Combination
Electrical-Mechanical
Collector

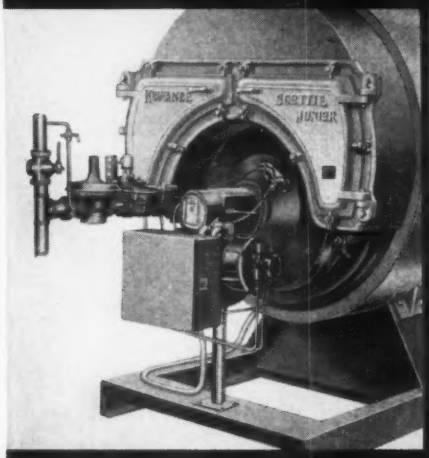
Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif. • Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.

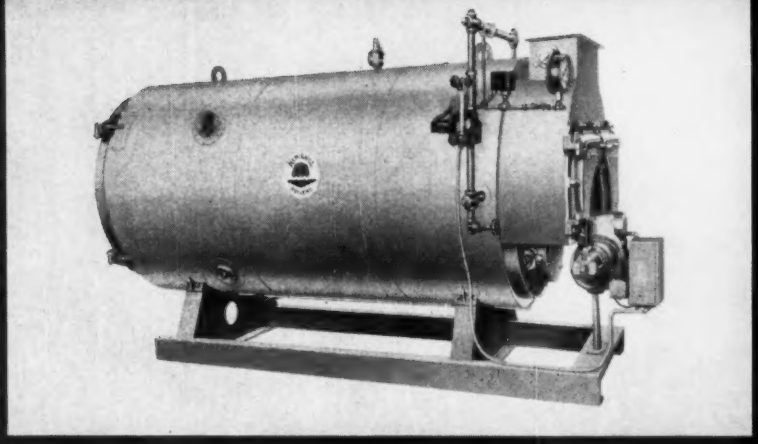
NEW!

KEWANEE®

FORCED-DRAFT



GAS-OIL COMBINATION FIRING for the new Kewanee package units is provided by this Kewanee burner designed for quick fuel change-over without adjustments.



NEW 606,000 TO 3,060,000 Btuh CAPACITIES: Kewanee Scottie Jr. low pressure boiler with Kewanee burner. Firing rate is balanced with boiler capacity. Oil burner (shown) is high pressure, twin nozzle type. Gas burner is equipped for either natural or LP gas.

another KEWANEE® quality product . . . proven in the field

Now . . . Kewanee provides 8 popular high pressure packages, 18 to 92 horsepower . . . 8 low pressure packages, 606,000 to 3,060,000 Btuh.

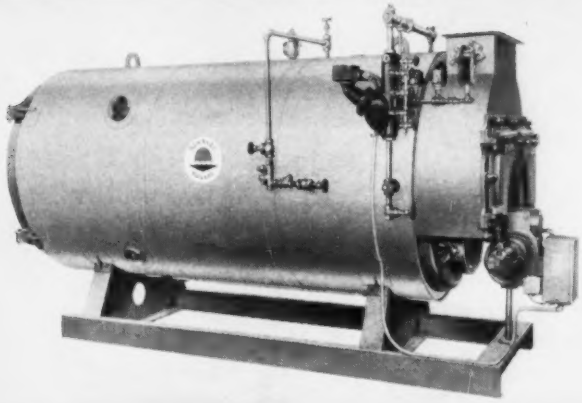
Forced-draft firing keeps combustion air supply constant, regardless of location or atmospheric conditions. Only a vent pipe is needed. The long, low lines of today's buildings are not violated by a costly, unsightly stack. Nor does the boiler room ceiling need to be higher than a standard 8 feet.

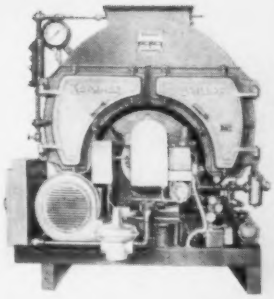
Fuel flexibility is provided by Kewanee burners for oil, gas or gas-oil combination firing. On combination units, fuel changeover is simple and fast . . . can be handled by automatic controls if desired.

Traditional Kewanee quality is engineered into the complete unit. Reserve strength is built into

18 TO 92 HORSEPOWER

PACKAGE UNITS





NEW 18 TO 92 HP CAPACITIES: For 125-150 swp or high temperature water above 250° F. Kewanee Scottie Jr. high pressure boiler with a Kewanee burner for oil (shown) or gas. Features include long gas travel, ample steam space, x-rayed and stress relieved welds.

OTHER LARGER KEWANEE BOILERS range up to 651 hp for high pressure . . . 21,855,000 Btuh for low pressure. Matching forced-draft burners are available for oil, gas and gas-oil combination firing.

all parts . . . moving parts are accurately machined to close tolerances. All features of design and construction are aimed at maximum dependability and long-range economy. Easy access is provided for boiler inspection and cleaning.

Kewanee factory-assembles the entire unit before shipping. The boiler is fitted with burner and controls at the factory, with controls housed in integral control panel. Boiler gages and controls are in place, as well as rear combustion chamber of high temperature refractory. Unit is shipped as a complete package—fire-tested if desired.

Send coupon at right for complete information. Clip it today and mail it to:

AMERICAN-STANDARD, KEWANEE BOILER DIVISION,
101 Franklin Street, Kewanee, Illinois.

American-Standard
KEWANEE BOILER DIVISION
101 Franklin Street • Kewanee, Illinois

KEWANEE 1958 90th year 1868

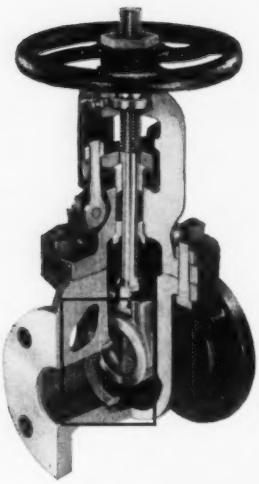
Please supply literature on the following Kewanee Boilers:

☐ low pressure ☐ new 18 to 92 h.p. packages
☐ high pressure ☐ all capacities

Name_____
Firm_____
Street_____
City_____ Zone_____ State_____

AMERICAN-Standard PRODUCTS

AMERICAN-Standard
KEWANEE BOILER DIVISION



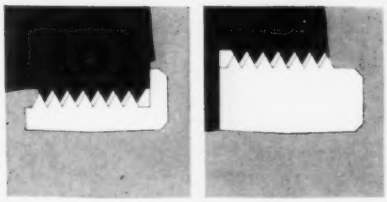
...and here's that same leakproof, streamlined seat ring– a steel valve feature, so good, we put it on our iron valves, too

OIC VALVES

BRONZE, IRON, FORGED AND CAST STEEL LUBRICATED PLUG VALVES

See how this *end*-seated ring fits into the valve body, out of the flow. It streamlines the body port, eliminates excessive pressure drop across the valve.

Here's how these rings reduce your maintenance problems . . .



Old-style, shoulder-seated ring cross section

OIC *end*-seated ring cross section

Old-style *shoulder*-type rings interrupt flow, cause turbulence. Since rings are seated in *tension*, they loosen and leak.

These OIC streamlined rings are *end*-seated in *compression* against the body. They can't loosen, even in continuous operation, so they won't leak.

3 OIC iron valve features that add to your maintenance savings

Yokes in all sizes permit replacement of the yoke nut when the valve is wide open, without interrupting flow.

T-head stem-wedge connection prevents wedge from binding when closing the valve. Closing is easy, positive, least wearing to trim parts.

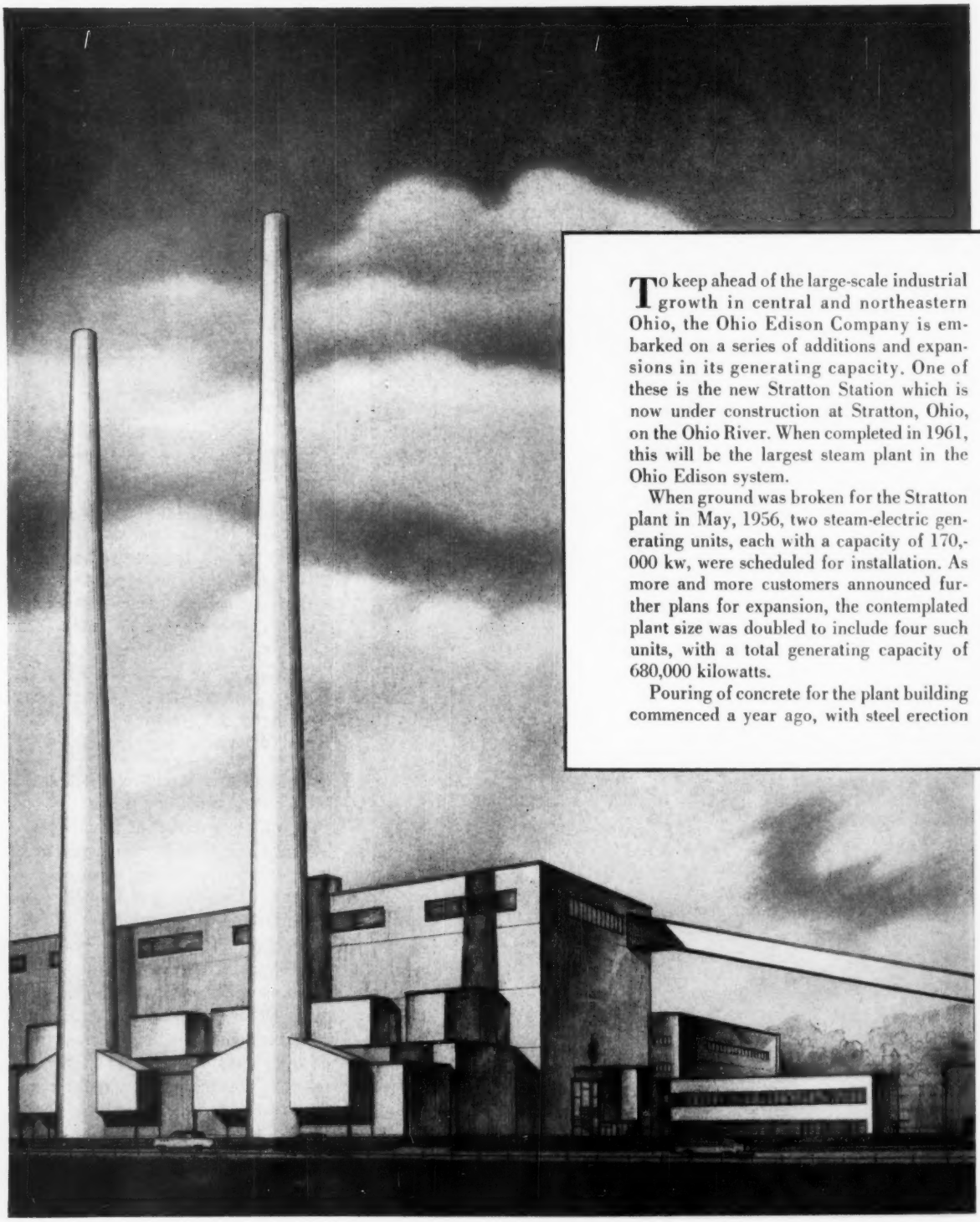
Threaded backseat bushing seals off upper bonnet of fully open valve. Makes repacking under pressure possible.

Choose for your service from 29 OIC iron valve numbers with 9 different trim and body metal variations. Order from your OIC Distributor or write for complete specification literature.

THE OHIO INJECTOR COMPANY

WADSWORTH, OHIO

At Ohio Edison's
FOUR FW STEAM GENERATORS



To keep ahead of the large-scale industrial growth in central and northeastern Ohio, the Ohio Edison Company is embarked on a series of additions and expansions in its generating capacity. One of these is the new Stratton Station which is now under construction at Stratton, Ohio, on the Ohio River. When completed in 1961, this will be the largest steam plant in the Ohio Edison system.

When ground was broken for the Stratton plant in May, 1956, two steam-electric generating units, each with a capacity of 170,000 kw, were scheduled for installation. As more and more customers announced further plans for expansion, the contemplated plant size was doubled to include four such units, with a total generating capacity of 680,000 kilowatts.

Pouring of concrete for the plant building commenced a year ago, with steel erection

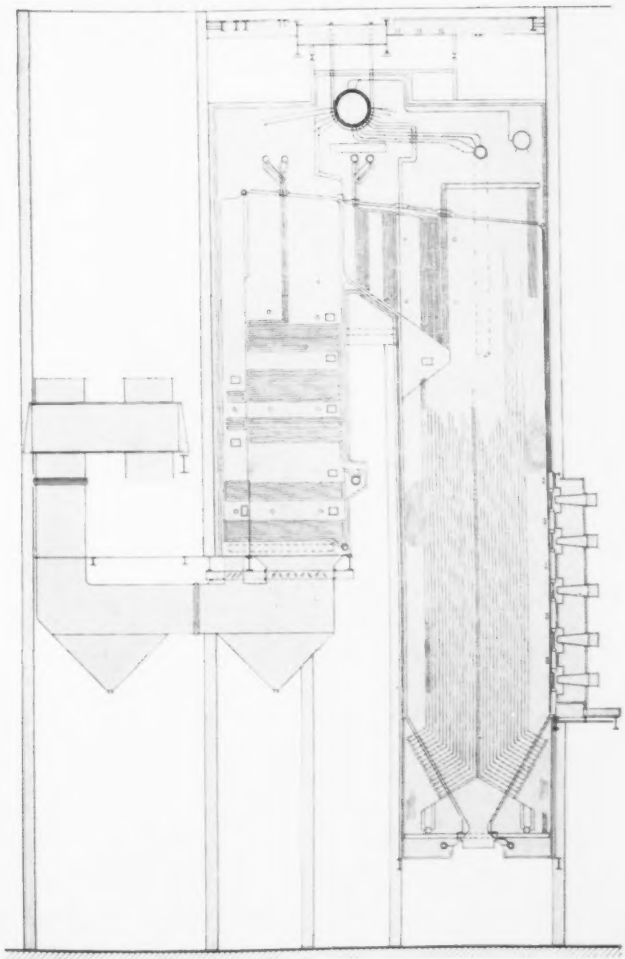
Largest Plant, will deliver 5,000,000 lb/hr

New Stratton Station, now under construction, will have capacity of 680,000 kw by 1961 — with four 170,000 kw units, each served by a FW 1,250,000 lb/hr Reheat Steam Generator

beginning last August. The first turbo-generating unit is scheduled to go into service late this year — the second next year, the third in 1960 and the fourth in 1961.

Steam for all units at Stratton Station will be supplied by four Foster Wheeler reheat steam generators with a combined capacity of five million pounds per hour. Each of these FW boilers will have a normal capacity of 1,250,000 lb/hr at a pressure of 2450 psig (2700 psig design) and a temperature of 1050 F at the superheater outlet. The reheat flow will be 1,040,000 lb of steam per hour at 430 psig and 1000 F.

With more than a half-century of experience in steam generation — and the finest modern manufacturing facilities in three large plants — Foster Wheeler welcomes the opportunity to quote on your requirements. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*



Architect's conception of the completed Stratton Station plant of Ohio Edison. Ground was broken for the plant in May, 1956. When the last of four units is installed at Stratton Station in 1961, it will have the largest capacity in the Ohio Edison system.

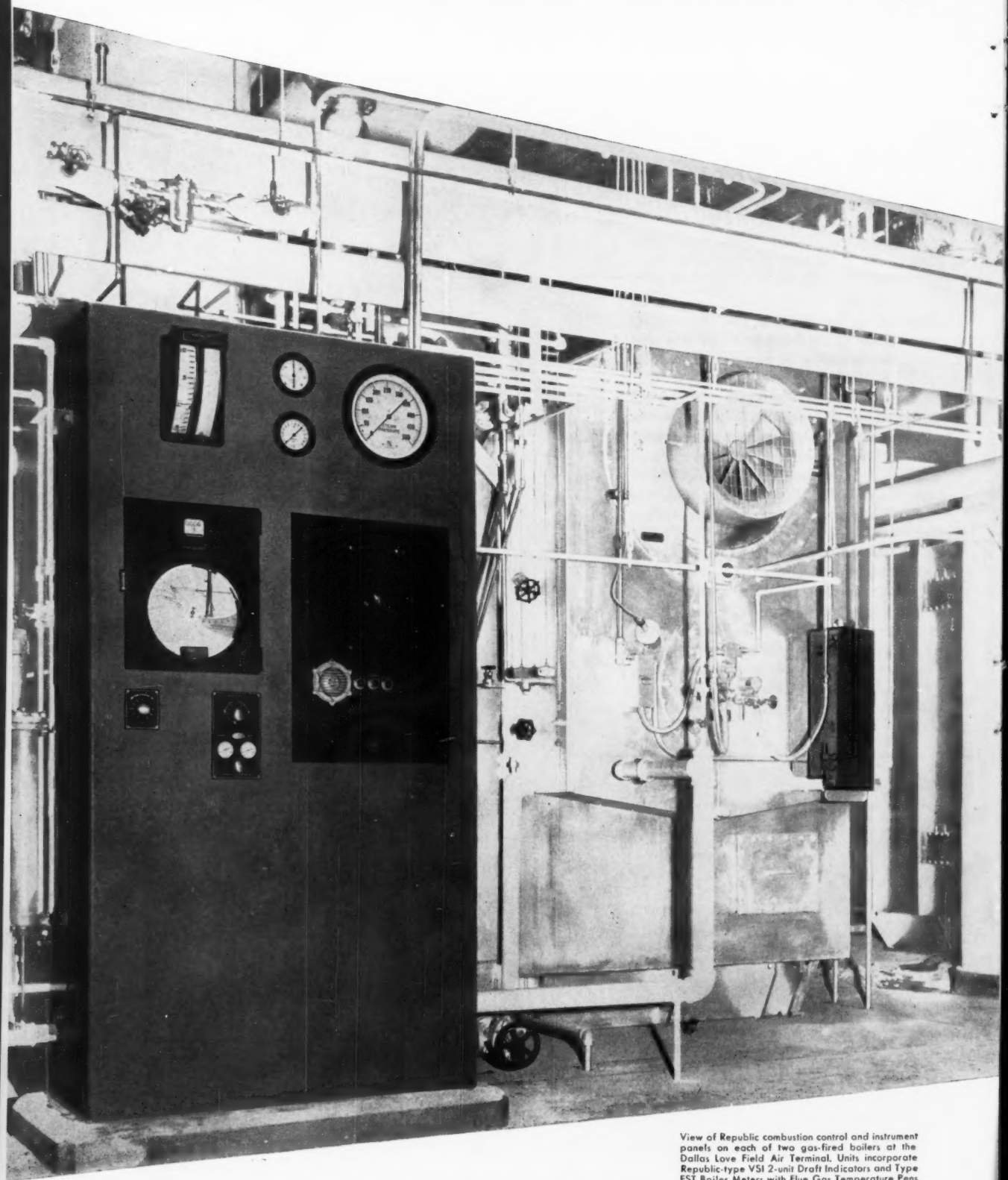
Cross section of reheat steam generator for Ohio Edison's Stratton Station. Four of these units have been ordered for the 680,000-kw plant. Each unit will supply 1,250,000 lb of steam per hour at 2450 lb/sq in. pressure, 1050 F primary steam temperature and 1000 F reheat temperature.

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

ANOTHER REPUBLIC ACHIEVEMENT!

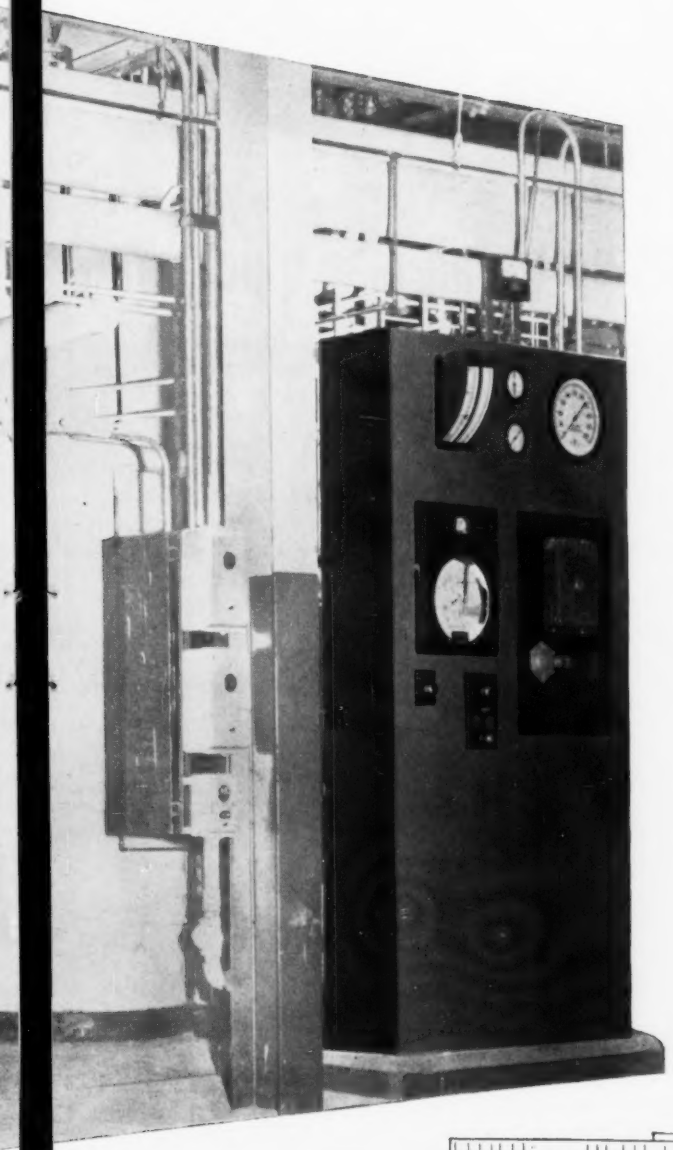
Republic Controls on Package



View of Republic combustion control and instrument panels on each of two gas-fired boilers at the Dallas Love Field Air Terminal. Units incorporate Republic-type VSI 2-unit Draft Indicators and Type EST Boiler Meters with Flue Gas Temperature Pens

Boilers Regulate "Indoor Weather"

...at Dallas' new Love Field Air Terminal



Complete Republic combustion control includes such features as on/off and modulating operation, instrumentation and flame failure control. This type of system operates two 15,000 lbs/hr package boilers, which supply 235 psi steam to centrifugal refrigeration compressors for the Terminal's air conditioning.

Republic's modern control designs are right at home in this $8,000,000 air terminal, which also features such innovations as touch control automatic doors, two-way moving sidewalks and carefully regulated "indoor weather". The new Love Field Air Terminal is truly one of the most modern in America.

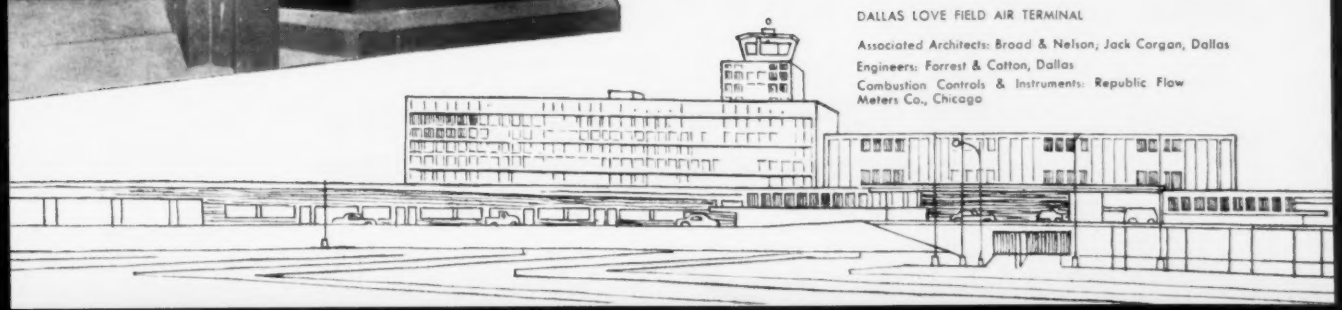
Advanced-design combustion controls, based on Republic's experience in plants of all sizes—from package boiler installations to large central station units—are your best guarantee of premium performance from your major equipment. A Republic engineer is ready to help with your instrument and control planning. Republic sales offices are located in principal cities throughout the U.S. and Canada.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

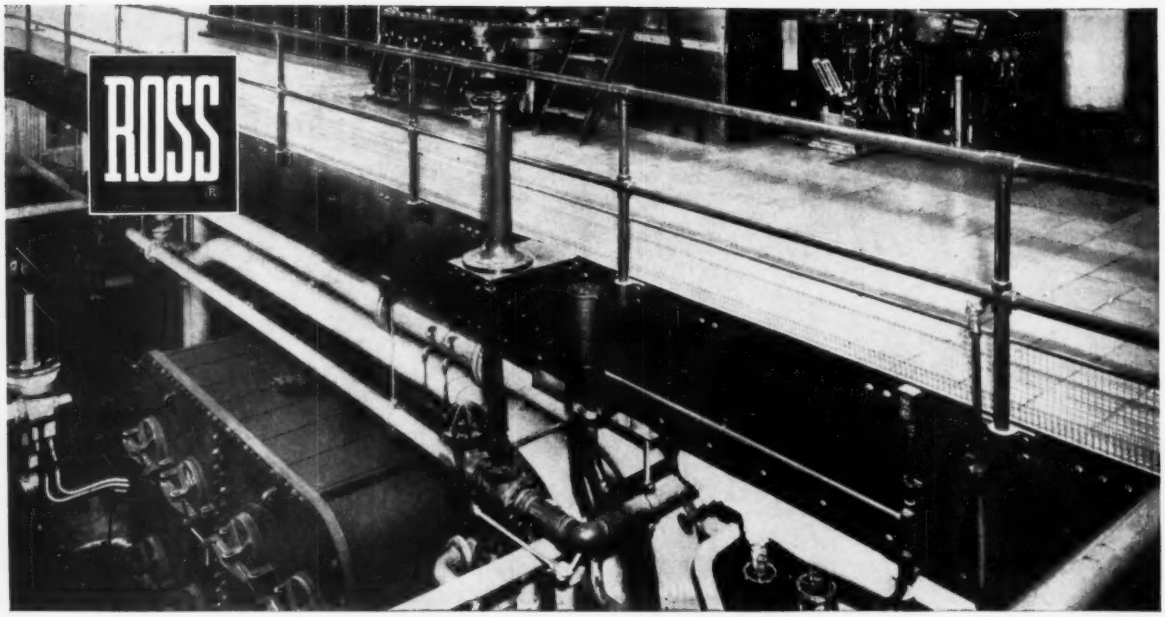
2240 DIVERSEY PARKWAY • CHICAGO 47, ILL.
In Canada:
REPUBLIC FLOW METERS CANADA, LTD. -TORONTO

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.



DALLAS LOVE FIELD AIR TERMINAL

Associated Architects: Broad & Nelson; Jack Corgan, Dallas
Engineers: Forrest & Cotton, Dallas
Combustion Controls & Instruments: Republic Flow Meters Co., Chicago



IN A SIDE-BY-SIDE COMPARISON...

"Ross Condenser brings turbine up to full load quicker"

On duty in a northwestern power plant, a Ross Surface Condenser is serving one of four identical 35,000 KW turbine-generator units.

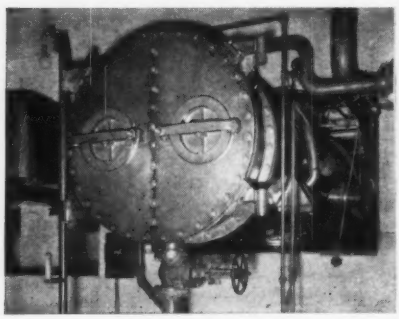
Although only one of the four condensers is a Ross unit (there are two other makes), the chief turbine engineer of this station singled it out for top performance: "The Ross Surface Condenser can bring the turbine up to full load quicker than any of the other condensers in this plant. It has been performing satisfactorily for 25 years. Our operators are well satisfied."

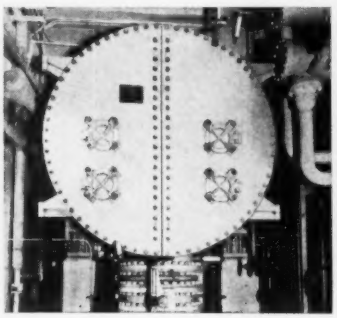
This is just one instance—there are numerous others (a few are also shown here) where Ross Condensers have clearly demonstrated superior efficiency and dependability. And this is not surprising. For over 40 years, Ross has set the pace in the design and construction of heat exchange equipment, by continually stressing advanced engineering . . . engineering that introduced the first all-welded steel surface condenser in the United States, and pioneered numerous other developments, including Balanced Flow and divided tube bank design.

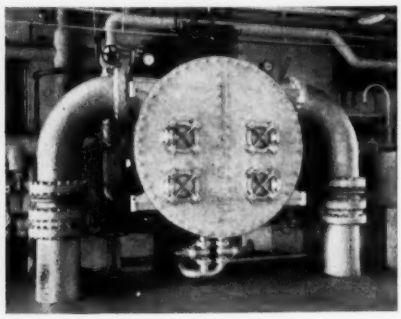
It's only logical then, that Ross is uniquely qualified to meet your surface condenser requirements. Consultation with Ross engineers will leave you assured of this.

For detailed information on Ross Twin Bank Condensers, or the smaller, Single Bank Type, request Bulletins 8.2K1 and 8.1K1 respectively.

American-Standard, Ross Heat Exchanger Division, Buffalo 5, N.Y. In Canada: American-Standard Products (Canada) Limited, Station D, Toronto, Ont.







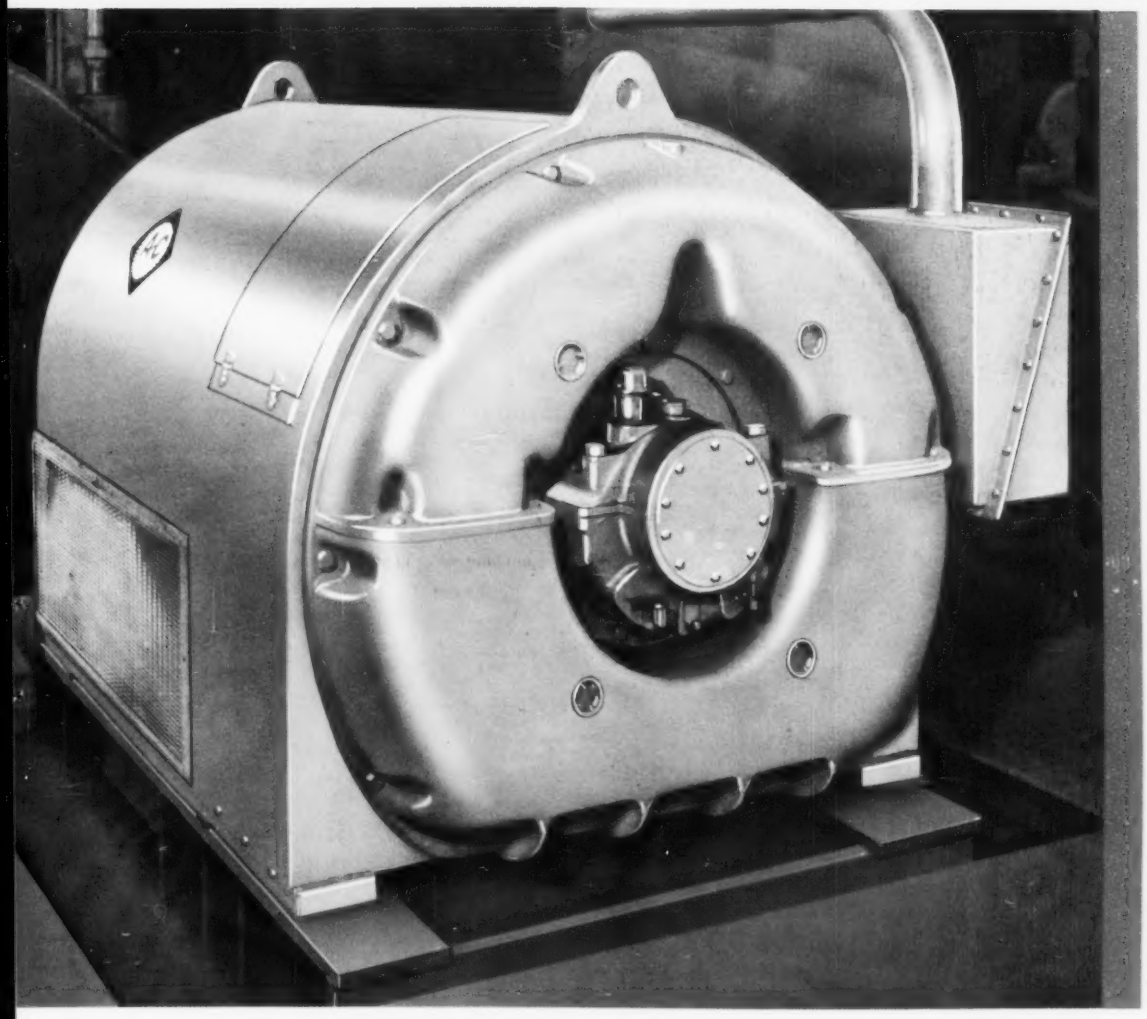
AMERICAN-Standard

ROSS HEAT EXCHANGER DIVISION

Revolutionary Advance in Motor Protection

made possible by SILCO-FLEX insulation

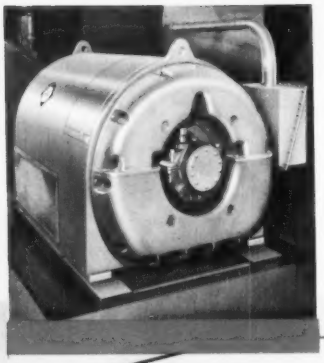
plus 10 integrated mechanical features



Designed to meet needs of chemical, paper, petroleum, metals, power and rock products industries where moisture, dirt, abrasive dusts or corrosive atmospheres are a problem.

ALLIS-CHALMERS

A-5636



New Motor is

super-sealed

It's drip-proof — yet withstands moisture • abrasive dust • chemicals • high humidity • heat

The *Silco-Flex* system of insulation is used on all stators. Field coils of synchronous motors are bonded in heat-stabilized resins, enclosed in a resin-impregnated sheath of oriented glass fibers and bond-locked on the pole structure.

The superior electrical protection of Super-Sealed motors results from the insulating *system* used... not just the insulating material. The same material, conventionally applied, would retain certain weaknesses of conventional insulation.

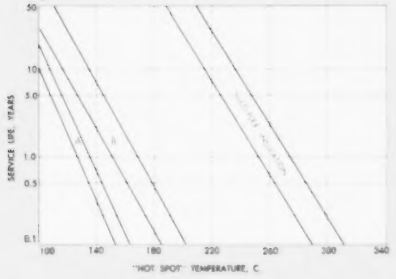
Applied the A-C way, it has these qualities that add reliability and service life:

Dimensionally stable — withstands heating, thermal shock, vibration and fatigue at elevated temperatures.

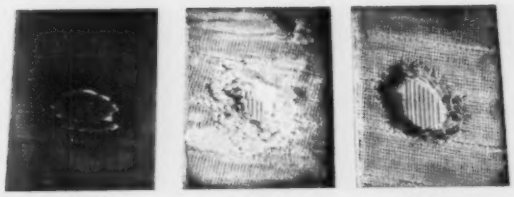
Sealed throughout — resistant to most chemicals, water, high humidity, weather, aging, corona and lubricants.

Homogeneous — provides a void-free dielectric barrier, homogeneous under extremes of differential expansion and contraction due to thermal cycling.

All Super-Sealed motors have revolutionary Silco-Flex insulation

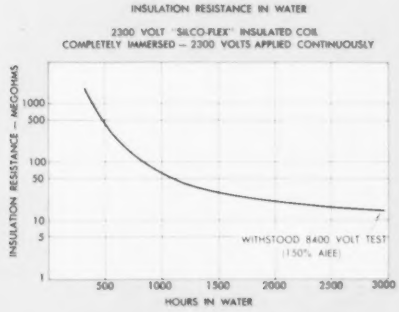


Heat resistant — *Silco-Flex* insulation gives much longer service life under higher temperatures than conventional materials.

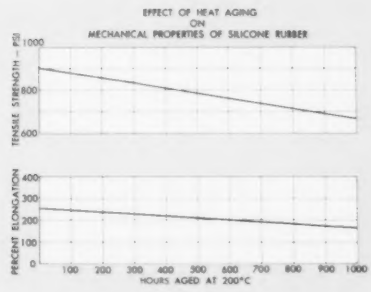


Silco-Flex Insulation | *Polyester Mica Tape* | *Asphaltum Mica Tape*

Abrasion resistant — Samples of insulation show effect after sandblasting for one minute with 90-grit aluminum oxide and 100-psi air. Nozzle to sample distance was six inches, thickness equivalent to 2300-volt insulation. Note difference in abrasion.



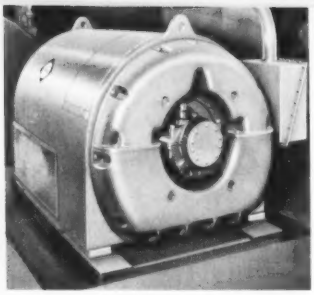
Moisture resistant — Test curve shows that *Silco-Flex* insulation, after 3000 hours of total immersion with 2300 volts impressed on coil, withstood high potential test of 8400 volts without injury.



Flexible, resilient — Rubbery *Silco-Flex* insulation remains flexible and resistant indefinitely. It is especially resistant to mechanical abuse and to stresses of overloading, rapid starting and stopping.

Silco-Flex is an Allis-Chalmers trademark.

ALLIS-CHALMERS



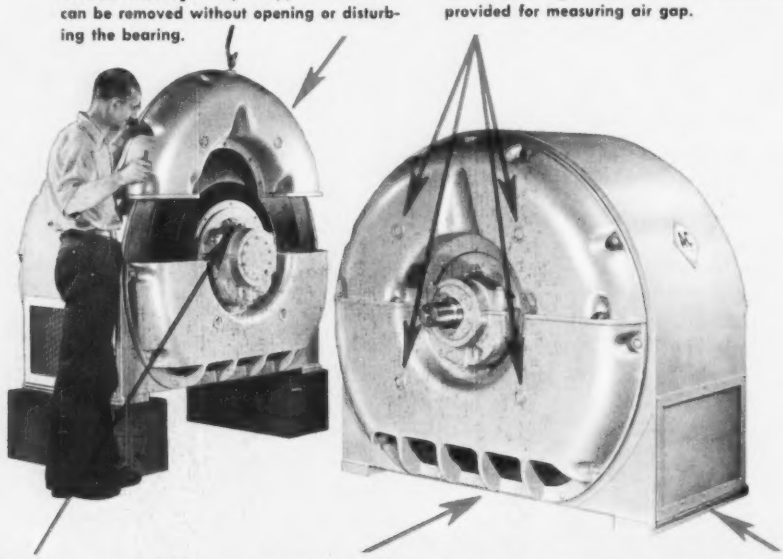
New Super-Sealed motors

10 mechanical features

Super-Sealed motors combine the perfect insulation with features that assure the mechanical as well as the electrical reliability of these motors.

Accessibility — Split-type end shields can be removed without opening or disturbing the bearing.

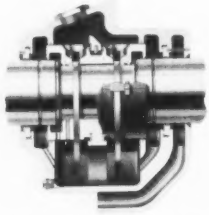
Ease of Inspection — Four points are provided for measuring air gap.



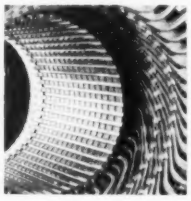
Clean Check — Glass inspection bulls-eye permits checking operation of oil rings without dirt falling inside bearing.

Full Circle of Protection — Steel plate across bottom of motor protects it from dirt and rodents.

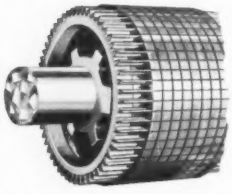
Clean Appearance — Foundation bolts are hidden, machine is clean-looking.



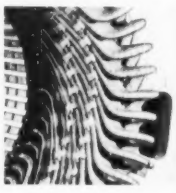
Self-Aligning Capsule-Type Bearings are center seated with single seat. Breather relieves pressure of oil in bearings that could cause leakage.



Precision Construction— Slot sticks are non-hygroscopic-trapezoidal, fabric base phenolic. End turns, spaced with polyester glass mat spacer pieces, are laced and tied with flat lubricated glass tubing for long trouble-free life.



Solid Construction—Silver-brazing rotor rods to end ring assures a good joint.



Rigid — End turns of higher speed motors are supported by insulated coil support rings to prevent injurious distortion due to high starting torque and frequent starting.

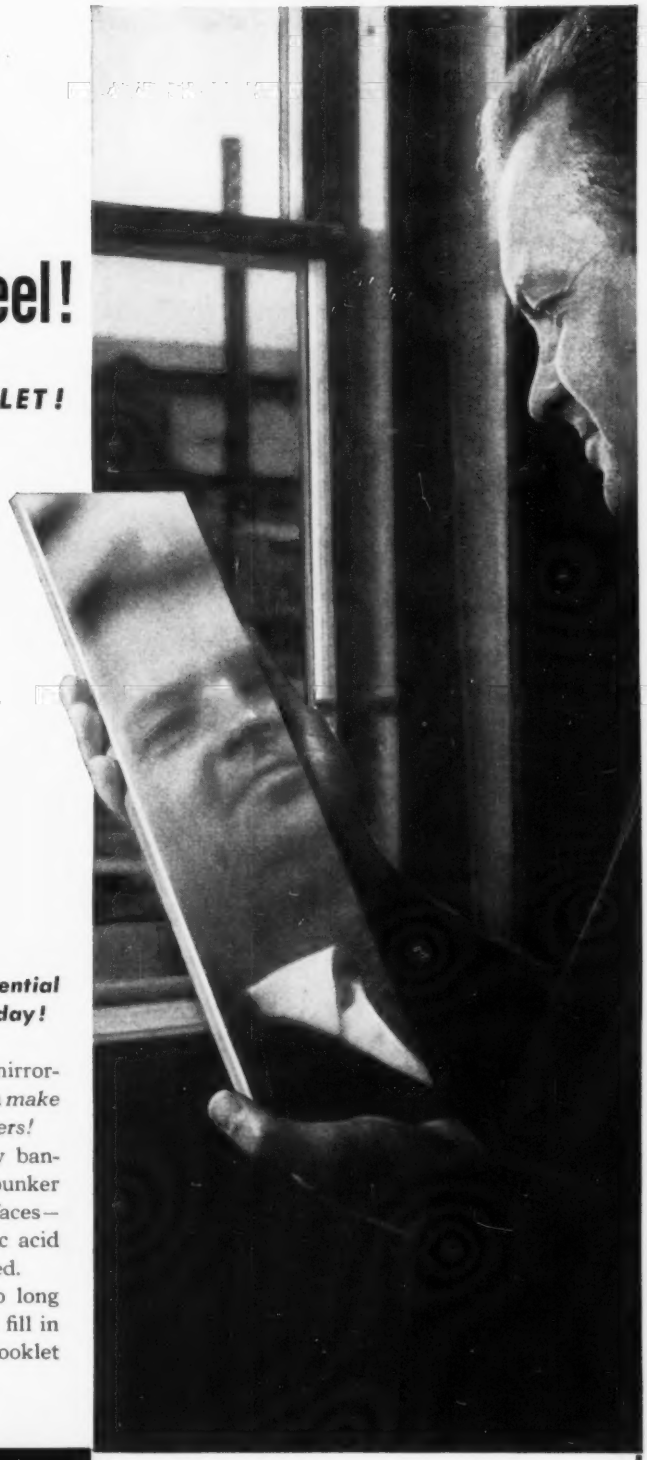
Timesavers—Separate plates provided to show direction of rotation and magnetic center. Terminal box is amply sized and diagonally split. Leads are brought out through grommet.

For the complete story, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

LOOK NOW
into Lukens clad steel!

GET THIS INFORMATIVE BOOKLET!



See for yourself how clad steel provides potential savings of $35,000! Send for your copy today!

In 16 figure- and fact-filled pages, it shows how mirror-smooth, corrosion-resistant stainless-clad steel can *make your coal handling equipment outlast your boilers!*

It tells you why stainless-clad steel virtually banishes coal hang-ups in your hoppers, chutes, bunker noses, pipes, spreaders. Prevents corroded surfaces—and resulting abrasive wear—caused by sulfuric acid in wet coal. Is easy to fabricate. Readily modified.

One short minute now can point the way to long years of economical coal handling—if you'll just fill in and mail the coupon. You'll get this important booklet at once. Lukens Steel Company, Coatesville, Pa.

Helping industry choose steels that fit the job

LUKENS ®

Manager, Marketing Service
LUKENS STEEL COMPANY
107 Lukens Building, Coatesville, Pa.
Please send me a free copy of your 16-page booklet, "Stainless-Clad Steel for Coal Handling."

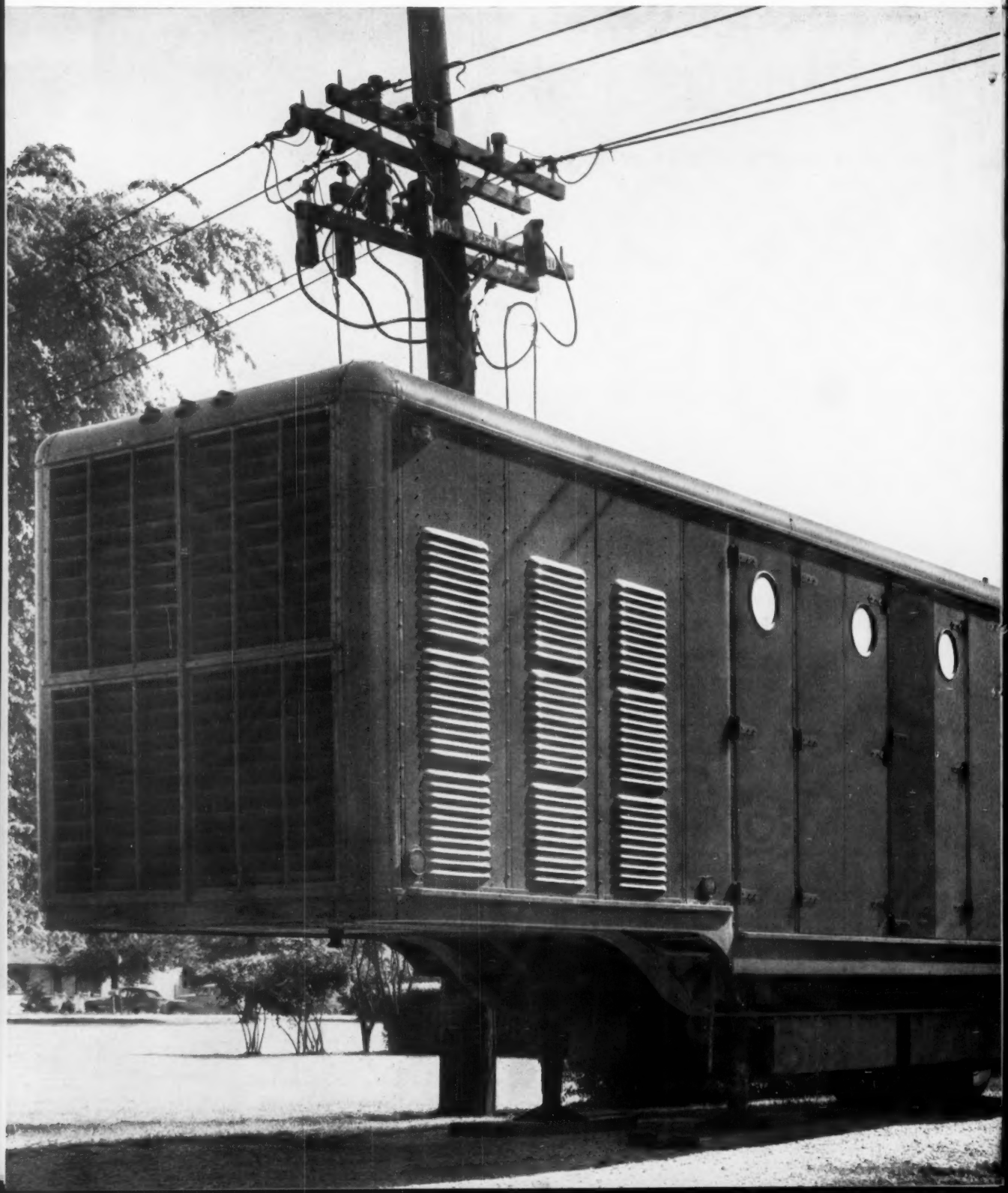
Name _____

Title _____ *Company* _____

Street Address _____

City _____ *Zone* _____ *State* _____

Line relocation



need not be costly

Not, that is, when work can be completed during regular hours and without interrupting service. And many utilities are doing just that—paring the high cost of line relocation and other maintenance and repair needs—with versatile Electro-Mobile generating units.

For example, a 500 kw trailer like the one shown here can travel most anywhere, pick up a load in minutes. Crews can do their work faster, at lower cost, and all the while *normal service* is maintained.

Further, these units can be utilized as an immediate source of emergency power. Their quick mobility can provide the means to continued service, and continued good public relations.

The economies of Electro-Mobile Power have been demonstrated on many utility applications. Why not ask your Electro-Motive representative to outline briefly ways these trailer units can help improve service and lower costs for your system?

1000 kw units for use on sidings or placed on piers for semi-permanent use.

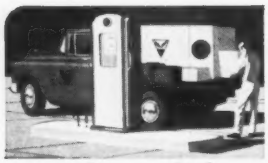
500 kw units offer excellent mobility for many temporary applications.

LIVE BETTER ELECTRICALLY

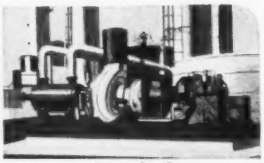
ELECTRO-MOTIVE DIVISION
GENERAL MOTORS
LA GRANGE, ILLINOIS

Sales offices in Chicago, New York, St. Louis, San Francisco
In Canada: General Motors Diesel Limited, London, Ontario

Four amazing advantages of Solar Gas Turbine Engines



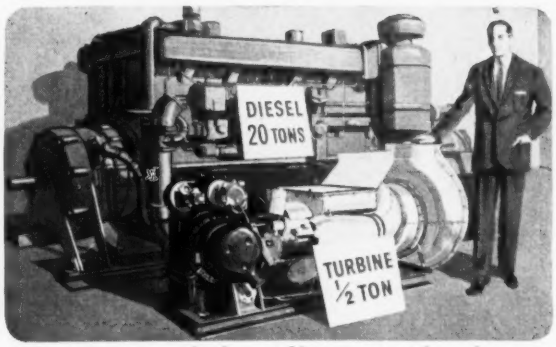
Gasoline—any kind.



Diesel oil

Kerosene.

Natural gas.



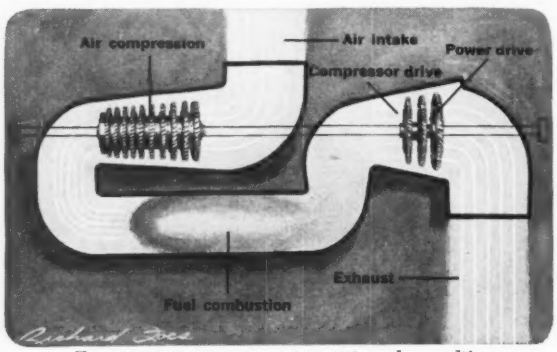
The Jupiter is completely portable—saves weight and space.

❶ Uses whatever fuel you've got!

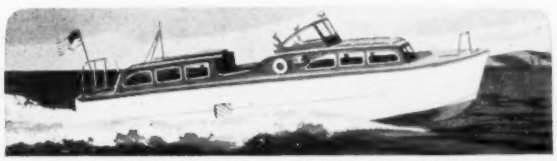
Solar gas turbines can operate on almost any available fuel—fuel that costs the least for *your* particular operation. Located in remote areas, for instance, self-sufficient Solar turbines can take fuel directly from a gas pipeline! This often results in lower total operating costs.

❷ Light—500 hp in 1/5 the space!

Solar's 500 hp Jupiter® engine is only one-fifth the size of a diesel of similar horsepower—and weighs *forty times less!* The entire unit is easily transported to remote locations. And it is especially suited to applications where space limitations create a troublesome installation problem.



Few moving parts, no reciprocation—longer life.



Instant acceleration—takes full load without laboring.

Instant emergency power.

Starts in any climate.

❸ Simple design—low maintenance!

Gas turbines are the simplest of all heat engines. In operation, large volumes of air are drawn in by the compressor, mixed with fuel in the combustion chamber, greatly expanded, and delivered to a turbine which produces shaft power. Routine servicing can be completed in a few hours at most. Overhauls are infrequent. Simple design and low maintenance make gas turbines ideal for a wide range of important applications—including boat propulsion, portable power generation, air compression and chemical processing. And other applications for these versatile power plants of the future are limited only by the imagination.

❹ Starts instantly—no warm-up!

Solar gas turbines can be turned on or shut down in seconds. And they require no warm-up—even after long periods of stand-by service. No matter what your business, no matter what your power needs, these amazing advantages can benefit you. Write to Dept. D-157 for free gas turbine brochure.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

2200 PACIFIC HIGHWAY • SAN DIEGO 12, CALIFORNIA

WHY LET YOUR FUEL DOLLARS GO UP IN SMOKE?

Packaged Ljungstrom® Preheaters increase efficiency for boilers as small as 25,000 lbs per hour! Money spent on fuel in a single year often equals the cost of the boiler itself! And with fuel prices continually rising, every BTU is doubly precious.

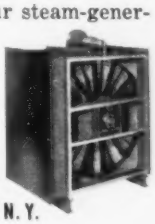
So don't let fuel dollars go up the stack—in smoke. Whether your boiler produces 25,000 or 250,000 pounds of steam per hour, the shop-assembled Ljungstrom preheater recovers heat—and dollars. Results: FUEL CONSUMPTION IS REDUCED! Generally 10% or more. This will usually write off the cost of a Ljungstrom in less than 2 years.

BOILER PRODUCTION IS INCREASED! By preheating air, higher temperatures in the furnace are assured, higher heat absorption and steam producing capacity are made possible.

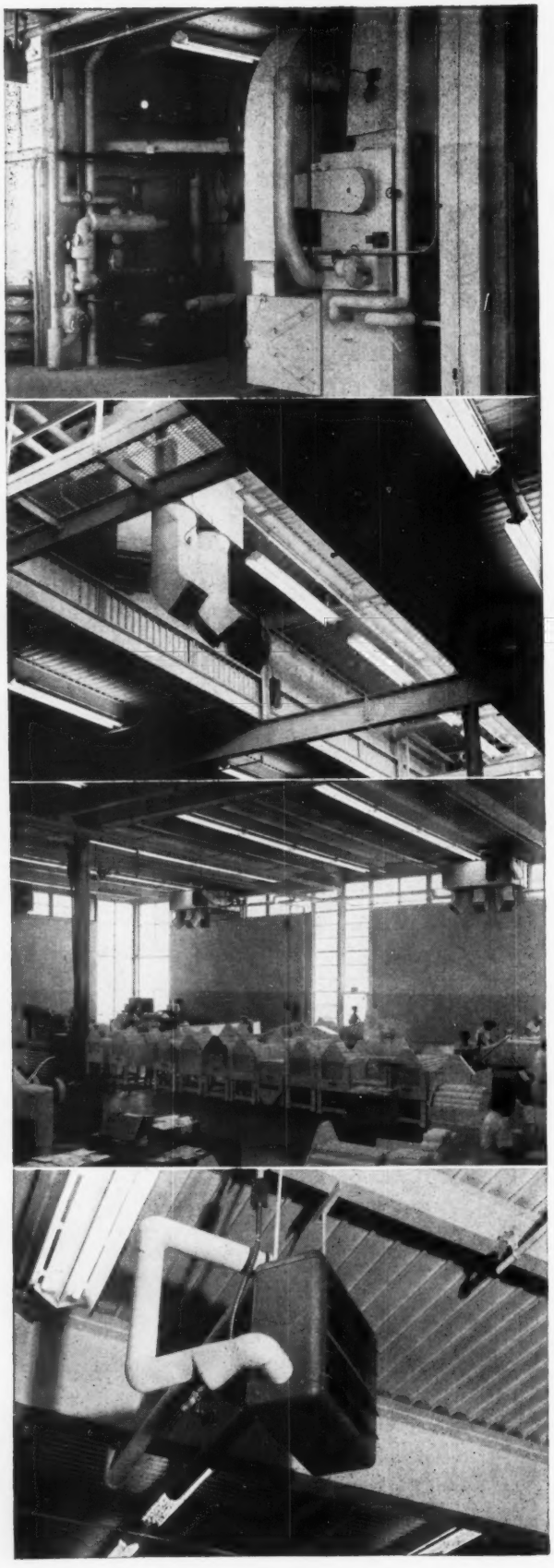
LESS MAINTENANCE NEEDED! Improved combustion means less slag, cleaner stack gases. Thus you benefit from fewer overhauls; longer service between shutdowns.

LOW GRADE FUELS PRACTICAL! Higher furnace temperatures permit effective burning of very low grade fuels.

COMES READY TO INSTALL! The Ljungstrom is shop-assembled, is easily applied to your steam-generating units. For details, contact The Air Preheater Corporation today. Ask for our free brochure.



The Air Preheater Corporation, 60 EAST 42ND STREET, NEW YORK 17, N.Y.



At top left is one of many "Buffalo" Central Station Air Conditioning Cabinets installed in Adhesive Plaster Mill of new Johnson & Johnson plant. These versatile units can be used for cooling and dehumidifying, heating and humidifying and/or air cleaning.

Second photo shows vertically suspended down-flow "Buffalo" Lowboy Heating Units used in Shipping Center. Ideal for heating large floor areas, these quiet, highly efficient units conserve valuable storage or production space.

At extreme upper left of third photo is a quiet, compact, efficient "Buffalo" Type "NV" Propeller Fan installation in Baby Products Plant. These economical "package" units for either direct or V-belt drive are shipped completely assembled, ready for quick, easy installation. At upper center and right of photo are two more "Buffalo" suspended Lowboy Heating Units, described above.

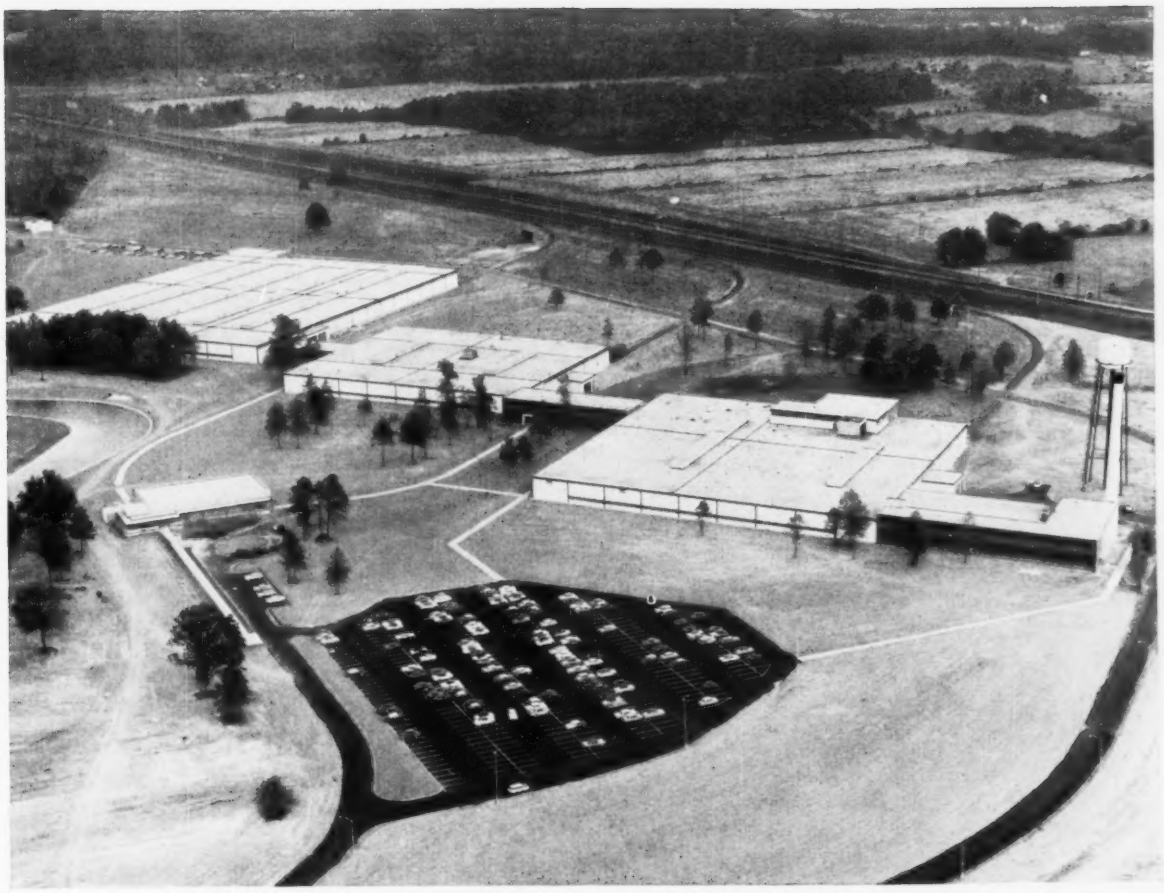
At lower left is one of the numerous "Buffalo" Breezo-Fin Unit Heaters installed in Shipping Center. The heater element is a one-piece copper tube with square copper fins, spaced to give maximum radiation. There is no possibility of inside leakage. The motor mount is welded one-piece construction.

COMPLEX PLANT HEATING

The sheer statistics of this new Johnson & Johnson plant are impressive. Located on a 300 acre tract, its 635,000 sq. ft. of floor space extend for nearly half a mile. It uses more than 1,000,000 watts of lighting, sufficient for a community of more than 900 homes. The complexity of its heating and ventilating system is indicated by the fact that it utilizes over 26 miles of piping.

"Buffalo" equipment was specified for this complex heating and air conditioning job for many important reasons:

> First, the high quality of the equipment itself . . . the "Buffalo" reputation for dependability, efficiency, advance-design, economy of operation down through the years.



Johnson & Johnson's Newest: World's Largest Surgical Dressings Plant at North Brunswick, N. J.

Engineers and Builders: Walter Kidde Constructors, Inc.,
Mechanical Contractors: Richardson Engineering Co.,
Sheet Metal Contractors: Middlesex Sheet Metal Co., Inc.

& AIR CONDITIONING PROBLEM SOLVED BY "BUFFALO" EQUIPMENT

Second, the **completeness** of the "Buffalo" line of heating and ventilating equipment . . . the wide variety of types, models and capacities to fit every possible application need. In all, "Buffalo" products quietly and efficiently handle a total of 928,000 CFM and 53,167,000 BTU/HR in this ultra-modern plant.

Third, the "Buffalo" record of more than 81 years of engineering experience, combined with modern-as-tomorrow design.

These are the sound reasons why "Buffalo" equipment was specified for the new Johnson & Johnson plant. They add up to very sound reasons for **you** to specify "Buffalo" equipment. When you plan **your** next plant heating and/or ventilating installation, be sure to call on "Buffalo". Contact your nearest "Buffalo" Engineering Representative, or write us direct for full information.

A Vital Component of Every "Buffalo" Product is the "Q" Factor — the Built-in QUALITY Which Provides Trouble-Free Satisfaction and Long Life.

BUFFALO FORGE COMPANY

488 Broadway • Buffalo, N. Y.

Canadian Blower & Forge Co., Ltd. • Kitchener, Ont.

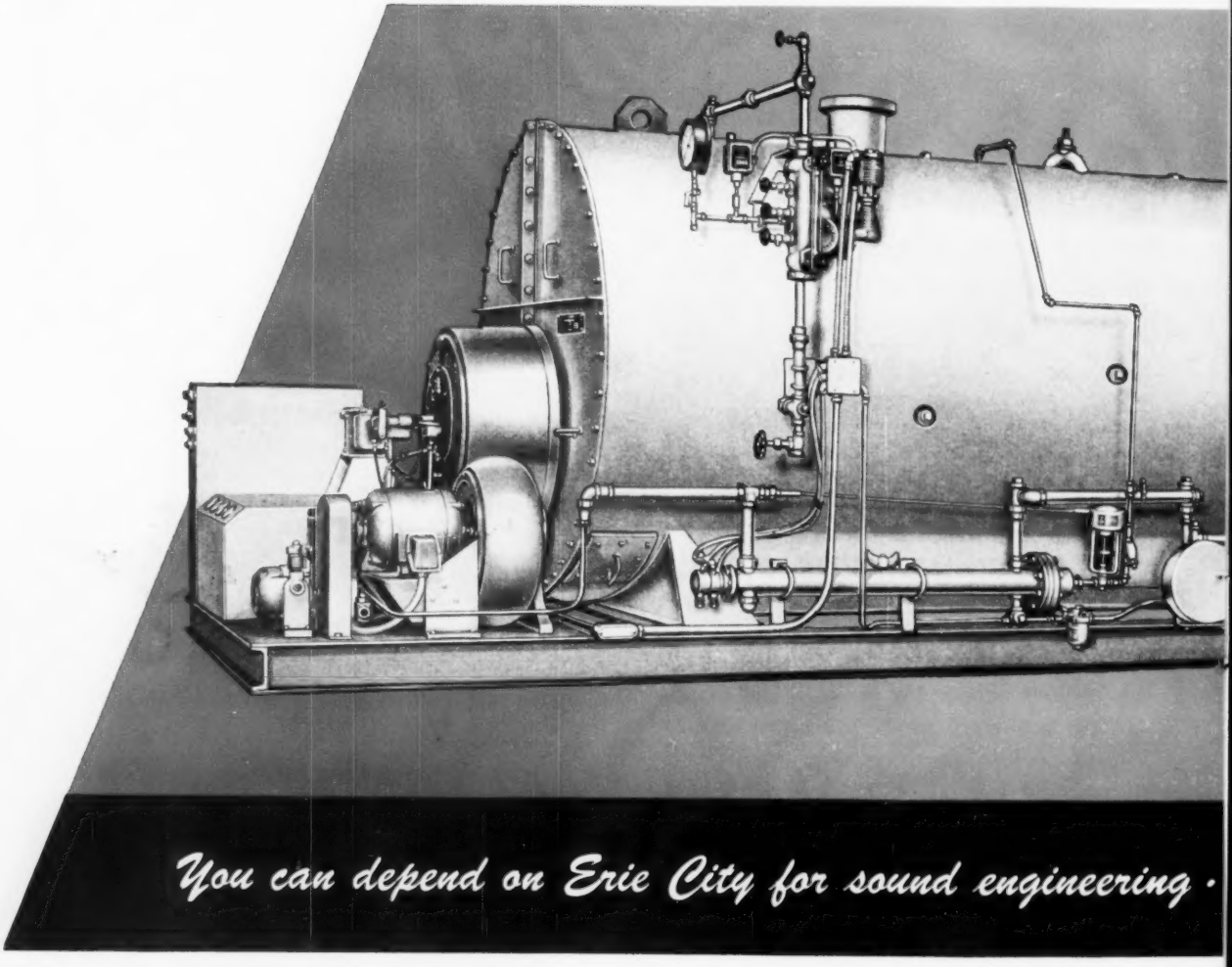
Sales Representatives in All Principal Cities

"Buffalo"

INDUSTRIAL EXHAUSTERS BELTED VENT SETS PROPELLER FANS "E" BLOWERS-EXHAUSTERS

ERIE CITY FT

the small boiler package



You can depend on Erie City for sound engineering.

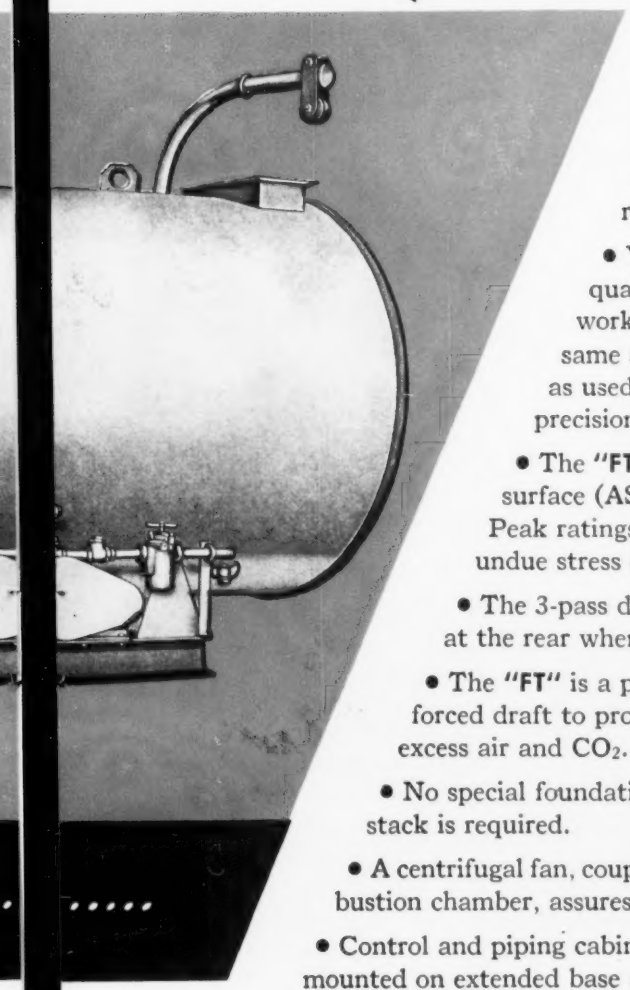
ERIE CITY
Since 1840

You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

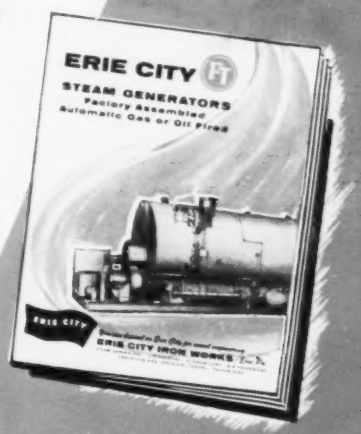
STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
FIRE AND WATER TUBE PACKAGE BOILERS • WASTE HEAT BOILERS
OIL AND GAS BURNERS • STOKERS • PULVERIZERS

for "PUSH BUTTON" steam with big boiler quality ~~~



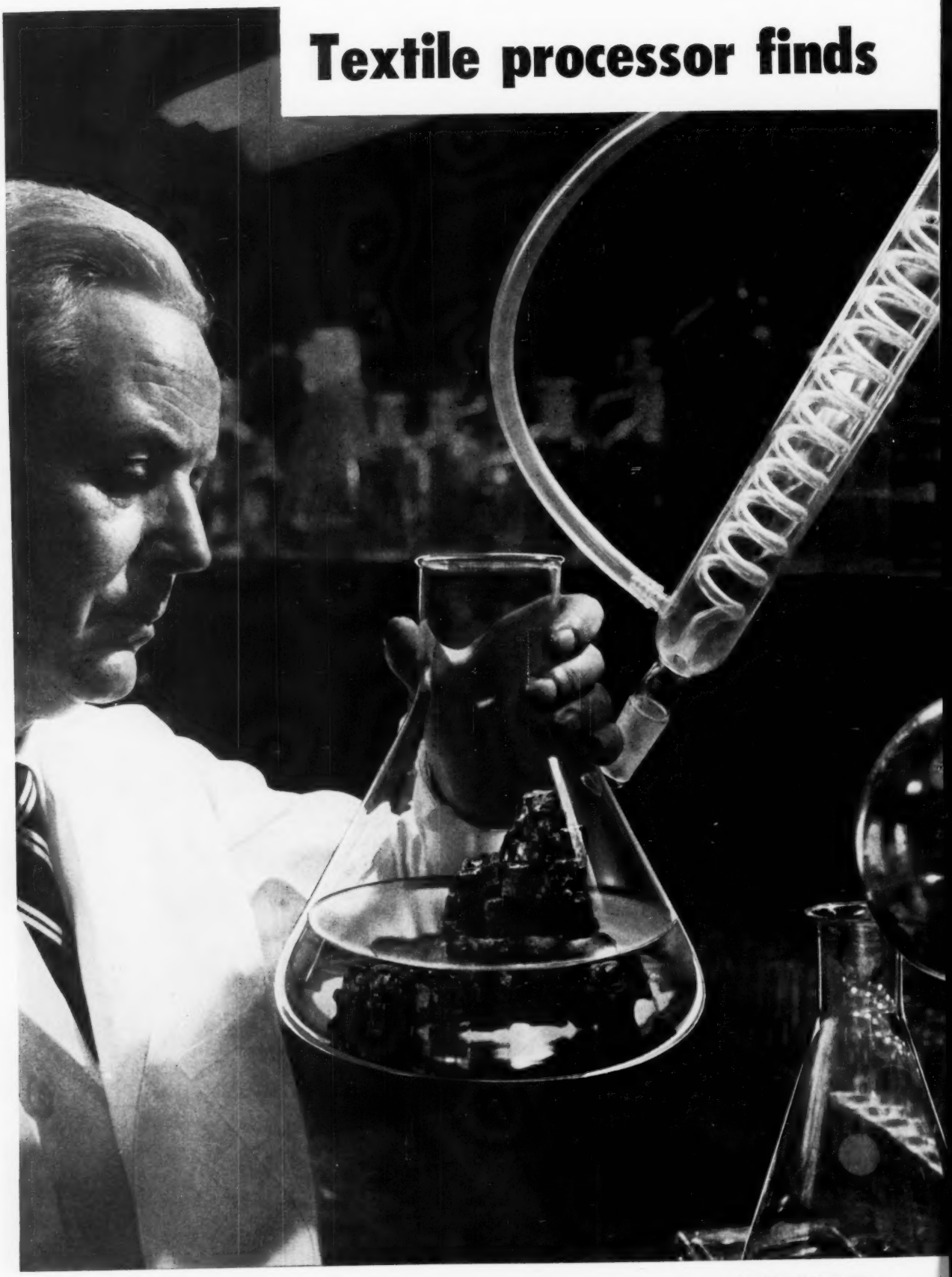
Backed by over a century of experience manufacturing high pressure water and fire tube boilers — the **"FT"** is manufactured, assembled, completely wired, piped and *factory fire tested*. It comes to you ready to go to work.

- You can be sure that the **"FT"** uses top quality materials — the same skilled workmanship — the same welding — the same stress-relieving and X-ray techniques as used on Erie City high pressure, precision built industrial power boilers.
- The **"FT"** has 5 full square feet of heating surface (ASME basis) per developed hp. Peak ratings are easily attainable with no undue stress on the boiler.
- The 3-pass design places the gas vent at the rear where it belongs.
- The **"FT"** is a pressurized unit using forced draft to provide precise control of excess air and CO_2.
- No special foundation nor expensive stack is required.
- A centrifugal fan, coupled to a closed combustion chamber, assures quiet operation.
- Control and piping cabinets are mounted on extended base away from heat and vibration.
- Every safety device is provided including indicating lights for "Power On"— "Ready"—"Pilot On" and "Main Flame."
- For the complete description of this top quality **"FT"** package that may cost a little more — but is worth it — write for SB- **569H**



Did you send for your copy of CATALOG SB-569H

Textile processor finds



fuel cost solution in coal

Kerr Bleaching & Finishing Works' modern equipment cuts steam costs 33%, manpower 67%.

A reliable source of steam is a necessity in bleaching and finishing textile products. So when production demands at Kerr Bleaching & Finishing Works, Concord, N. C., called for additional steam capacity, the firm decided to build a new power plant. Coal was chosen as the fuel on the basis of cost studies.

A new boiler and modern coal handling system were installed. Automatic controls regulate the operation. The results were a 50% increase in steam capacity and a 67% reduction in manpower . . . with overall fuel and operating costs cut over 33%!

This modern unit was so successful—providing trouble-free operation and low-maintenance cost—that when even greater capacity was needed, an identical new unit was added. And, of course, no increase in operating crew was necessary!

Facts you should know about coal

Not only is bituminous coal the lowest-cost fuel in most industrial areas, but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment pares labor costs and eliminates smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

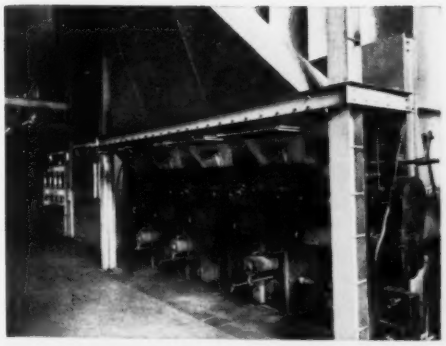
To help you with industrial fuel problems the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case histories, complete with data sheets. You'll find them informative.

Consult an engineering firm

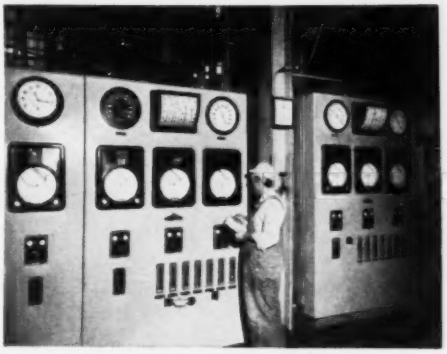
If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

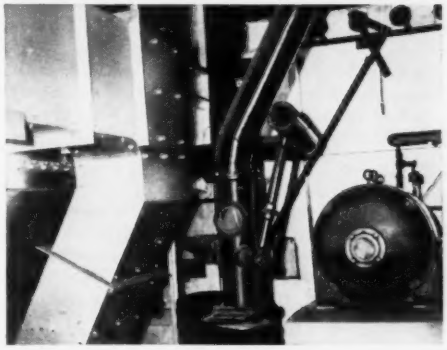
Southern Building • Washington 5, D. C.



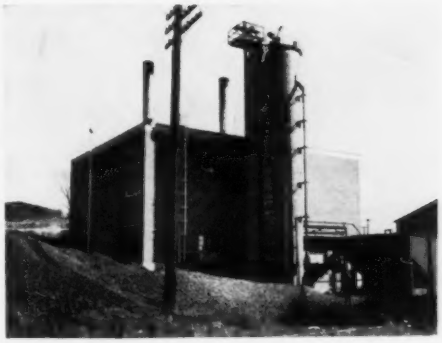
Firing aisle at the power plant of Kerr Bleaching & Finishing Works, showing two Babcock & Wilcox 60,000 lb/hr boilers—the more recent on the right. Fired by Detroit spreader-type Rotostoker, with steam-powered dump grates.



Control panels of Bailey Pneumatic Control System. Fuel feed, draft dampers, feedwater control—entire combustion operation is automatically regulated by this system.

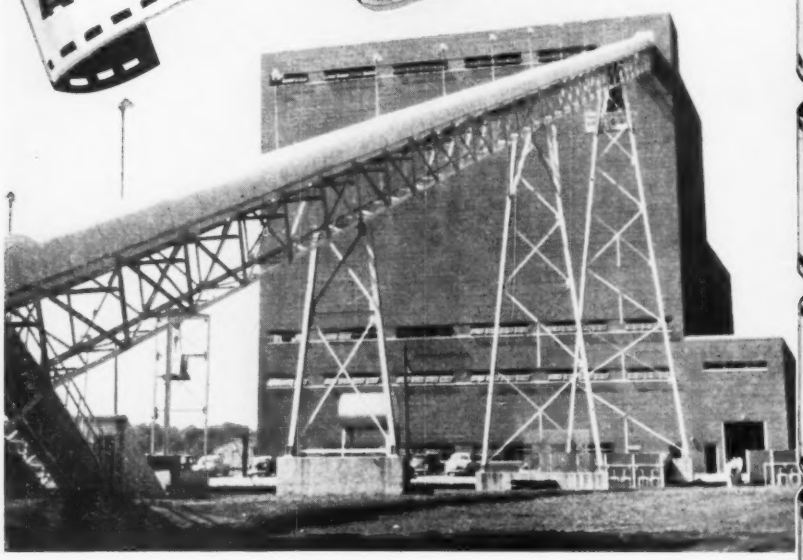


View in rear of Boiler No. 2. Pipe in center of photograph returns fly ash from collector to furnace to be burned again. Motor on the righ: drives induced draft fan.



Rear of Kerr's power plant showing the 250-ton coal storage silo. Coal is dumped into hopper by railroad car and carried by horizontal conveyor to bucket elevator at silo. Reserve coal pile is shown at left.

A Websterama OF ECONOMICAL COAL HANDLING



Twin track hopper receives run-of-mine coal from cars assisted by car shaker, and loads double reciprocating plate feeder.

Plate feeder discharges to inclined Belt Conveyor #1–212' long. Magnetic pulley ejects tramp iron at discharge to crusher or by-pass chute.

Under crusher, coal can be fed to Conveyor #2 or #4. Coal sampling equipment is located in chute to Conveyor #2. Inclined Conveyor #2 is 341' long from crusher house to Conveyor #3 (over bunkers in main building).

Conveyor #3, equipped with automatic self-propelled Webster tripper, distributes coal to 104' long bunker. Each compartment of bunker has Webster gate and scale to automatically record fuel used.

Stocking-out Conveyor #4 is 43' long and discharges to yard storage. Coal is reclaimed through system as previously described.

The complete coal handling system is electrically interlocked for movement of coal without fear of jam-up.

This WEBSTER 300-ton-per-hour coal handling system built for the City of Richmond, Indiana, could well be described as "an introduction to automation." It was designed to meet the most modern requirements for automatic, efficient handling of coal, with a minimum of maintenance and operational attention. In addition to the conveying system, WEBSTER also supplied the masonry crusher house, which includes dust-tight control room, locker room, bulldozer garage, plus crusher room and sampling equipment.

Whether you intend to construct a new power plant or modernize an old one, WEBSTER engineers will be pleased to cooperate with your engineers or engineering firm in applying 81 years of WEBSTER experience to your coal-handling problems. Write Dept. P-38 today.

WEBSTER MANUFACTURING, INC.
TIFFIN, OHIO

Offices in All Principal Cities

ELEVATING AND CONVEYING MACHINERY · SINCE 1876 ·

Consulting Engineers
BLACK & VEATCH
Kansas City, Mo.

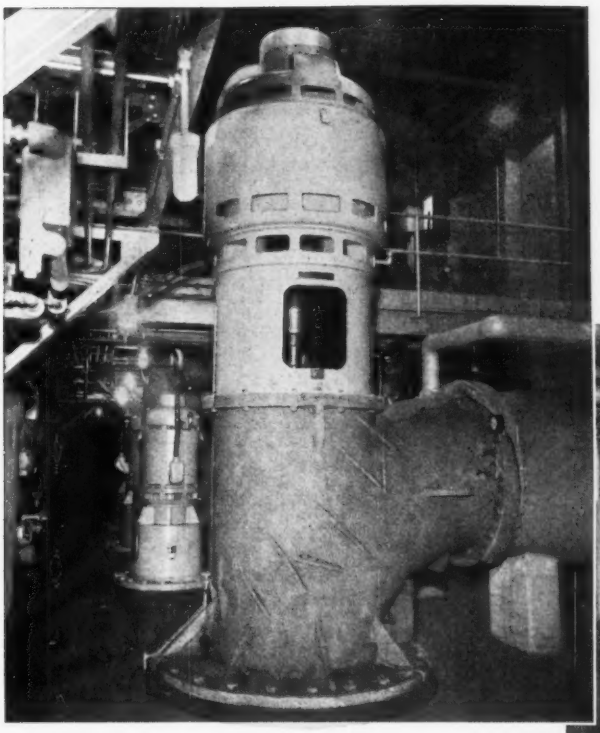
All component parts were built in the Webster plant at Tiffin, Ohio.

Webster

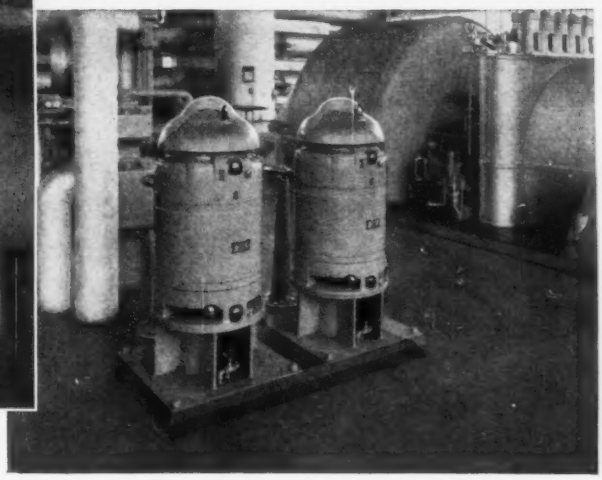
SINCE 1876
BULK MATERIALS HANDLING EQUIPMENT

I-R VERTICAL Pumps

designed and built to meet your specific



CIRCULATING and CONDENSATE application



Ingersoll-Rand Class APM vertical propeller pumps offer many advantages for condenser circulating service. Vertical design with submerged suction simplifies installation and piping... "Pull-Out" construction permits removal of the pumping element for inspection without disturbing the pump mounting or the discharge flange bolting... Discharge can be located above or below floor level... Pumps are self-priming and have only one stuffing box – accessible from floor level and not under pressure... Impeller clearances can be adjusted from top of driver, without disturbing piping...Available in capacities to 150,000 gpm, heads to 50 ft. per stage.

Class APHC vertical turbine-type condensate pumps require very little floor space and permit simple, straight-through piping connections located either above or below floor level . . . Single, readily-accessible stuffing box and top-of-shaft adjustment for rotor clearances simplify maintenance and reduce down-time... All units are self-venting... Impellers are vertically stacked in from 1 to 9 stages, for heads to 575 ft. and capacities to 3000 gpm.

The cost-saving features mentioned above are backed by excellent records of dependable, trouble-free service year after year. That's why more and more power companies are specifying I-R Verticals for circulating and condensate service. Ask your I-R representative for complete details and specifications on the pumps best suited to your needs.

10-391

Ingersoll-Rand

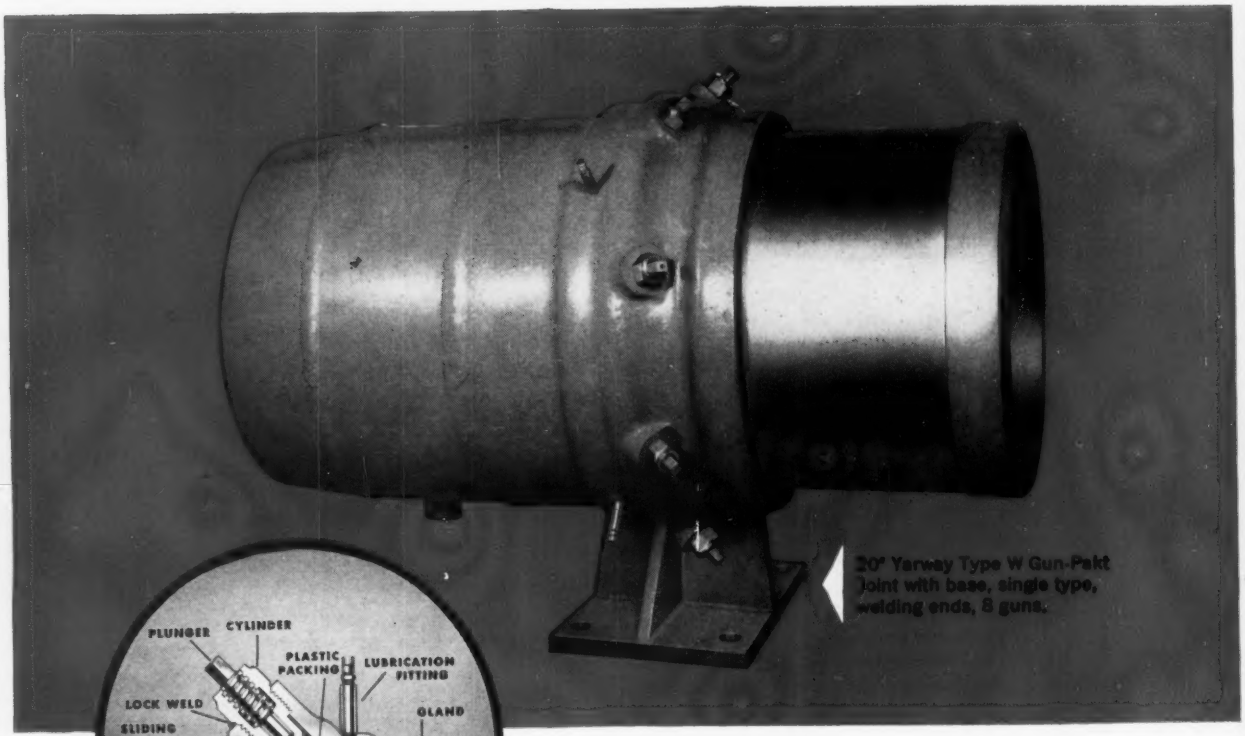
11 Broadway, New York 4, N.Y.

COMPRESSORS • GAS & DIESEL ENGINES • AIR & ELECTRIC TOOLS
CONDENSERS • PUMPS • ROCK DRILLS • VACUUM EQUIPMENT

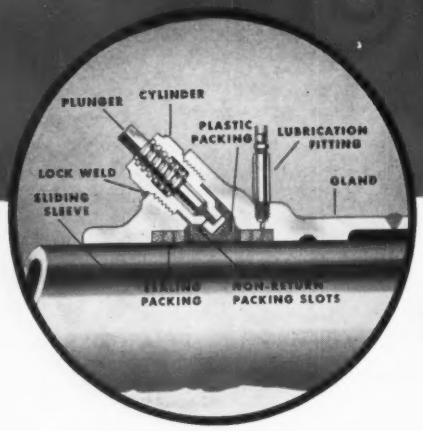
new savings

for expansion joint users...

YARWAY TYPE W GUN-PAKT



20" Yarway Type W Gun-Pakt Joint with base, single type, welding ends, 8 guns.



Cross-section of Gun-Pakt feature. To add packing, just add a plug and turn the plunger. Note non-return packing slots at bottom of cylinder.

YARWAY® GUN-PAKT

The Yarway Type W Gun-Pakt Expansion Joint has an improved one-piece design of body and gland and improved method of packing that provide new maintenance economies and greater operating efficiency.

Bolted joint between body and gland is eliminated; the steel body includes gland and guide. Shorter face-to-face dimensions are possible. Improved angle of packing guns makes them more accessible and *permits injection of the special plastic packing directly into packing space.*

The famous Yarway *Gun-Pakt* feature permits *addition of packing under full steam pressure. No need for costly shutdowns to repack.*

Sizes 1½" to 30", pressures 150, 300, 400 psi. Single or double types, flanged or welding ends.

For full description, write for new Yarway Bulletin EJ-1916.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

TYPICAL GUN-PAKT EXPANSION JOINT USERS

PUBLIC SERVICE & MUNICIPAL

Detroit Edison Co.
Georgia Power Company
New England Gas & Electric Corp.
Pacific Gas and Electric Co.
Philadelphia Electric Co.
Rochester (N.Y.) Gas & Electric Co.
Toledo Edison Co.
Wisconsin Electric Power & Light Co.

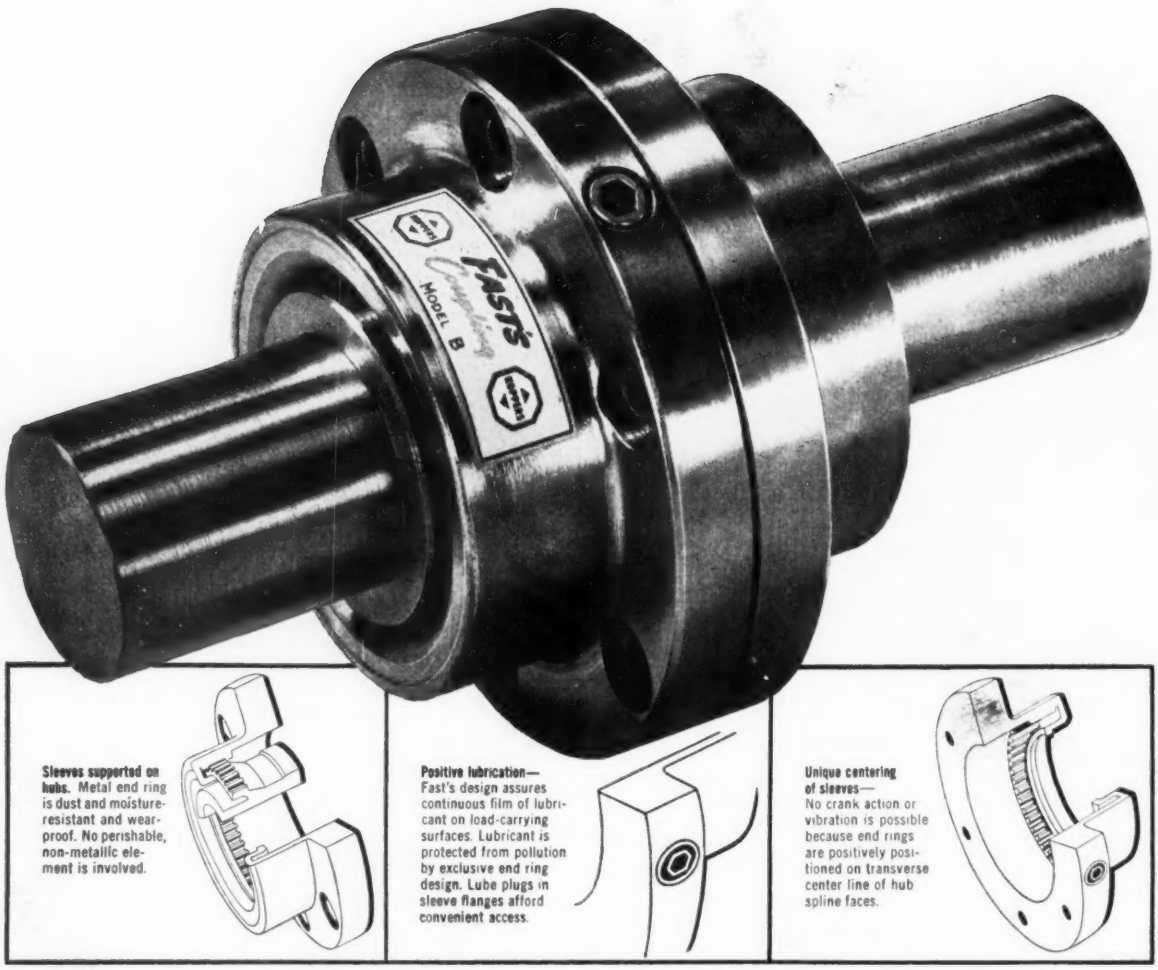
INSTITUTIONS & GOV'T BLDGS.

Boston State Hospital
Central Heating Plant, Washington
Massachusetts Institute of Technology
McGill University
Ohio State University
University of Chicago
University of Kansas
University of North Carolina

INDUSTRIAL PLANTS

Carbide & Carbon Chem. Corp.
Dow Chemical Corp.
Ford Motor Co.
General Electric Company
General Motors Corp. (Buick Div.)
Procter & Gamble Co.
Socony Vacuum Co.
Union Bag & Paper Co.

...a good way to specify expansion joints



Sleeves supported on hubs. Metal end ring is dust and moisture-resistant and wear-proof. No perishable, non-metallic element is involved.

Positive lubrication— Fast's design assures continuous film of lubricant on load-carrying surfaces. Lubricant is protected from pollution by exclusive end ring design. Lube plugs in sleeve flanges afford convenient access.

Unique centering of sleeves— No crank action or vibration is possible because end rings are positively positioned on transverse center line of hub spline faces.

Fast's Model B coupling reduces downtime and upkeep for light-to-medium drives

Mechanical flexibility eliminates costly shutdowns and expensive shaft replacements. But—it's only one of many cost-saving features.

Now you can profit from the durability and economy of famous Fast's couplings in a smaller and lower-cost version—available in 5 sizes for shafts ½″ to 3⅛″ in diameter.

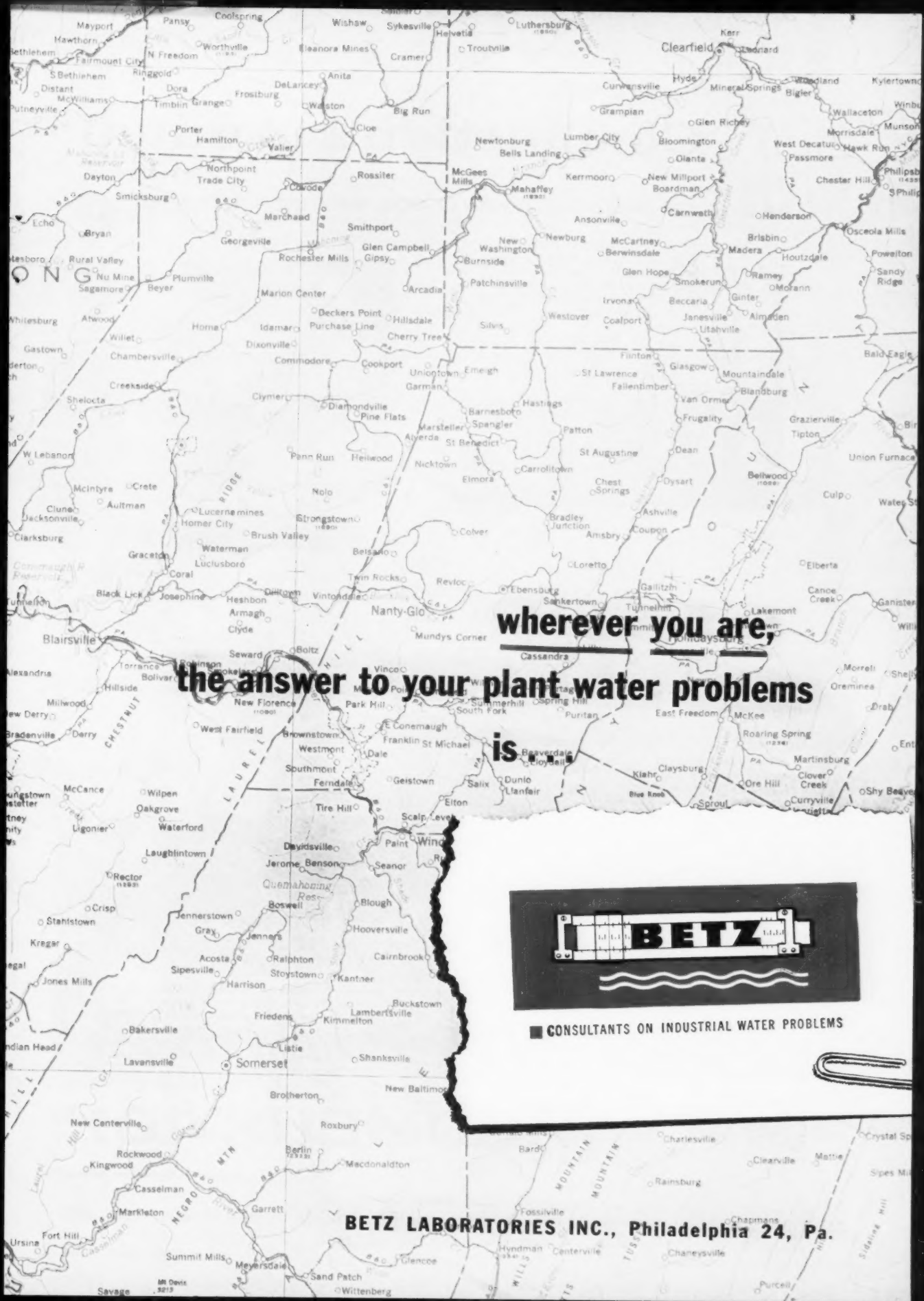
The Model B coupling gives you the same features that have made Fast's the world's leading coupling for over 35 years. You get the same trouble-free performance, longer service life and lower maintenance costs. You also get prompt delivery because stocks are on hand to meet practically every need. Free engineering service is also available.

Write today for more details to KOPPERS COMPANY, INC., Fast's Coupling Dept., 3303 Scott Street, Baltimore 3, Md.

Engineered Products
Sold with *Service*

KOPPERS

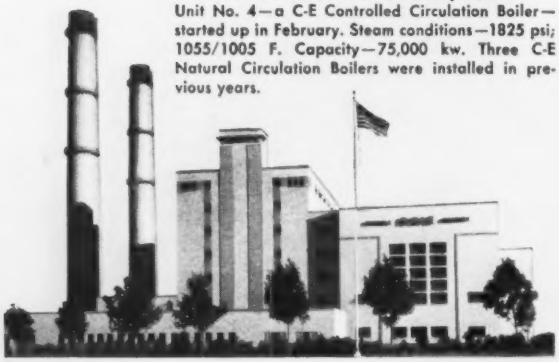
THE ORIGINAL
FAST'S Couplings


wherever you are,
the answer to your plant water problems
is
BETZ
CONSULTANTS ON INDUSTRIAL WATER PROBLEMS
BETZ LABORATORIES INC., Philadelphia 24, Pa.

Combustion's Annual

A FEW OF THE MANY POWER STATIONS IN WHICH C-E BOILERS WERE PLACED IN SERVICE IN 1957

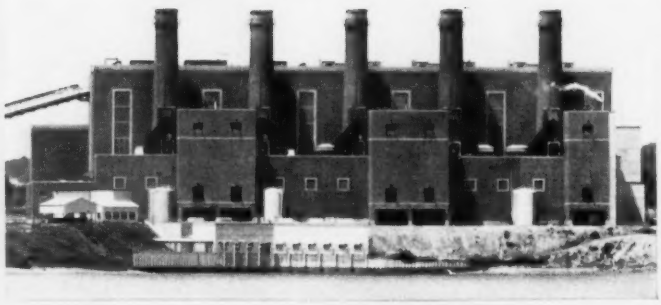
RUSSELL STATION
Rochester Gas and Electric Corporation
Unit No. 4—a C-E Controlled Circulation Boiler—started up in February. Steam conditions—1825 psi; 1055/1005 F. Capacity—75,000 kw. Three C-E Natural Circulation Boilers were installed in previous years.



GULF COAST STEAM PLANT
Mississippi Power Company
Unit No. 1—a C-E Natural Circulation Radiant Reheat Boiler — started up in June. Steam conditions—1875 psi; 1000/1000 F. Capacity—75,000 kw. A duplicate of this unit is now on order.

WILL COUNTY STATION
Commonwealth Edison Company
Unit No. 7—a C-E Controlled Circulation Boiler—started up in June. Steam conditions—2100 psi; 1050/1050 F. Capacity—275,000 kw.

GALLATIN STEAM PLANT
Tennessee Valley Authority
Unit No. 2—a C-E Controlled Circulation Boiler—started up in May. Steam conditions—2035 psi; 1053/1053 F. Capacity—275,000 kw. A duplicate unit is already in service and two similar units are on order.



POTOMAC RIVER STATION
Potomac Electric Power Company
Unit No. 5—a C-E Controlled Circulation Boiler—started up in May. Steam conditions—1875 psi; 1050/1000 F. Capacity—103,000 kw. Two duplicate boilers and two C-E Natural Circulation Boilers were installed in previous years.

COMBUSTION

Combustion Engineering Building

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS:

Statistical Report

Here are some statistical highlights of C-E work which reveal the part Combustion is playing in supplying steam for the nation's electrical requirements and in contributing to the general advancement of power practice. In the industrial area too, C-E is making some record-breaking installations. Notable among them, the world's highest capacity *package* boiler (100,000 lb of steam per hr), and the highest pressure, highest temperature *package* boiler (1800 psi and 1050 F).

Capacity of Units Placed in Service in '57 — 3,650,000 Kw.

C-E Controlled Circulation Boilers account for well over half of this new capacity. *All* units for turbine throttle pressures in excess of 1900 psig and capacities in excess of 125,000 kw are of the controlled circulation type.

Capacity of Units Ordered in '57 — 4,600,000 Kw.

Again C-E Controlled Circulation Boilers account for more than half of the total capacity as well as for *all* units in the 1900-up pressure class. Capacities of the controlled circulation units range from 75,000 to 500,000 kw, with four units above 300,000 kw.

Capacity of Units for 2400 Psig and Above Ordered to Date — 8,415,000 Kw.

85 per cent of this capacity is accounted for by C-E Controlled Circulation Boilers. C-E Sulzer Monotube Steam Generators account for the remaining 15 per cent.

Controlled Circulation Capacity in Service and on Order — 20,000,000 Kw.

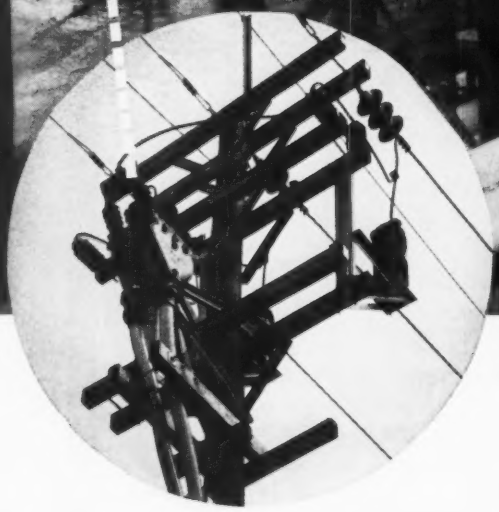
Such large-scale acceptance of a new design of boiler in so short a time — since 1950 — is unparalleled. 20,000,000 kw is about 20 per cent of the present steam generated capacity of the entire utility industry — a capacity that has taken more than three quarters of a century to accumulate.

ENGINEERING C-E

C-146A

200 Madison Ave., New York 16, N. Y.

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE



new 15kv Loxarmor* circuits eliminate conduit, allow simple terminations

Stainless steel Loxarmor cable was recently chosen by the Petro-Tex Chemical Corporation, jointly owned by Tennessee Gas Transmission Co. and Food Machinery and Chemical Corp., for main feeder circuits in their Houston, Texas plant.

Heart of this system is Okolite insulation applied by Okonite's strip-insulating method. The advantages inherent in the Loxarmor construction add considerably to the basic advantages of the Okolite insulation.

Advantages of Loxarmor construction:

. . . stainless steel armor provides the ultimate resistance to corrosive atmospheres prevalent in petrochemical plants.

. . . reduces installation and maintenance costs because of flexibility and the elimination of rigid conduit. Open type construction permits quick, simple inspection of your electrical system.

. . . completely salvageable—can be reused at will or can be easily re-routed.

. . . standard fittings permit relatively simple terminating procedures.

Petro-Tex Chemical Corporation's use of this construction typifies the modern trend to Loxarmor. Where the maximum security of a rigid conduit is not necessary, Loxarmor is a highly acceptable alternate.

Bulletin PW-1090 provides a thorough description of Loxarmor, providing engineering information, splicing and terminating drawings and instructions, and a discussion of the various components. Loxarmor power and control cables are available with any of Okonite's strip-insulated and extruded rubber insulations or with varnished cambric and plastic dielectrics. Write for it today to The Okonite Company, Passaic, N. J.

***Okonite's trade name for interlocked S-shaped armor—available in stainless or galvanized steel, aluminum or bronze. Protective coverings can be applied over the armor for special corrosion and chemical resistance.**

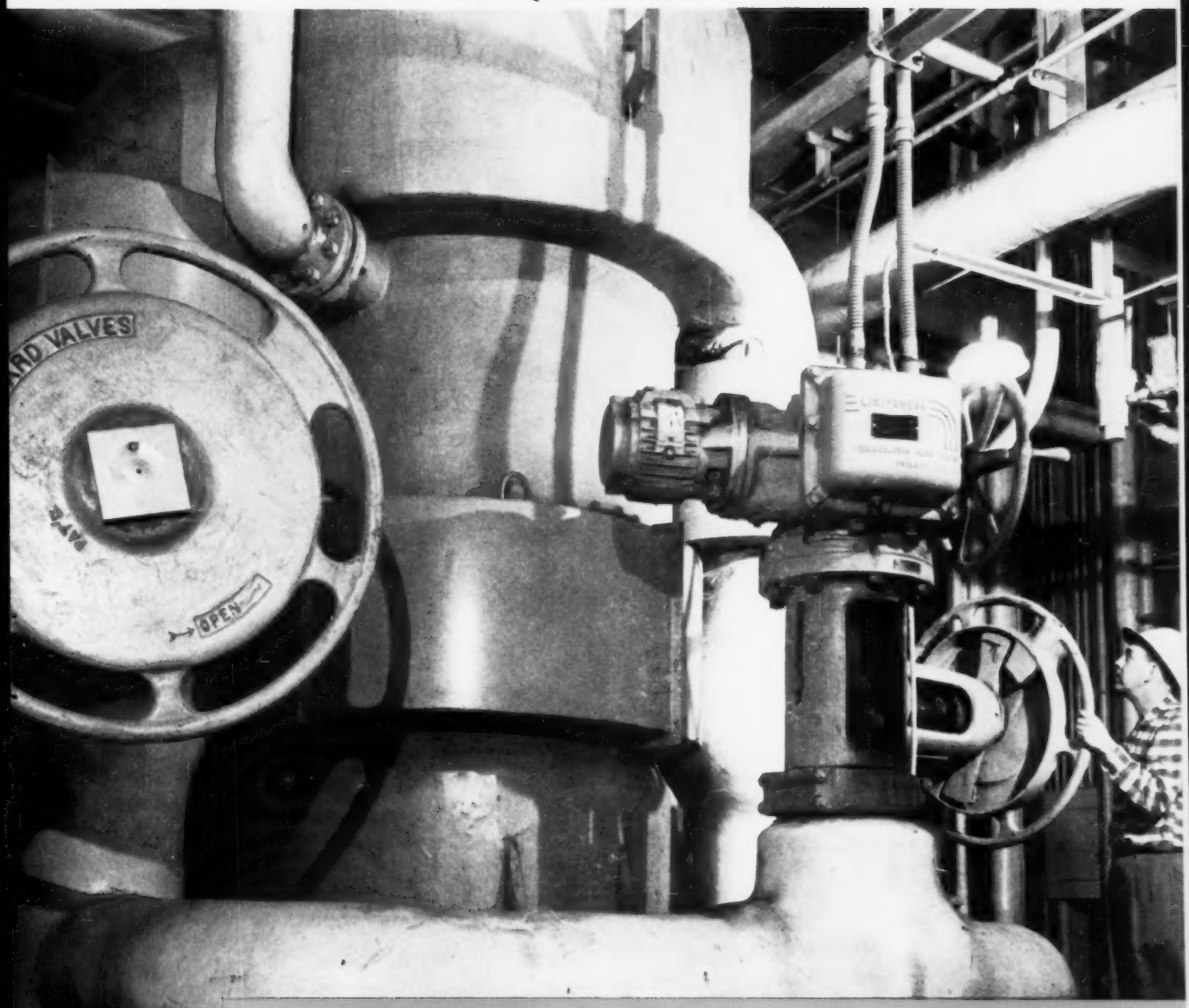
4710

where there's electrical power . . . there's **OKONITE CABLE**

Edward valve values

Edward Valves, Inc. Subsidiary of ROCKWELL MANUFACTURING COMPANY
EAST CHICAGO, INDIANA

FIRST QUARTER 1958

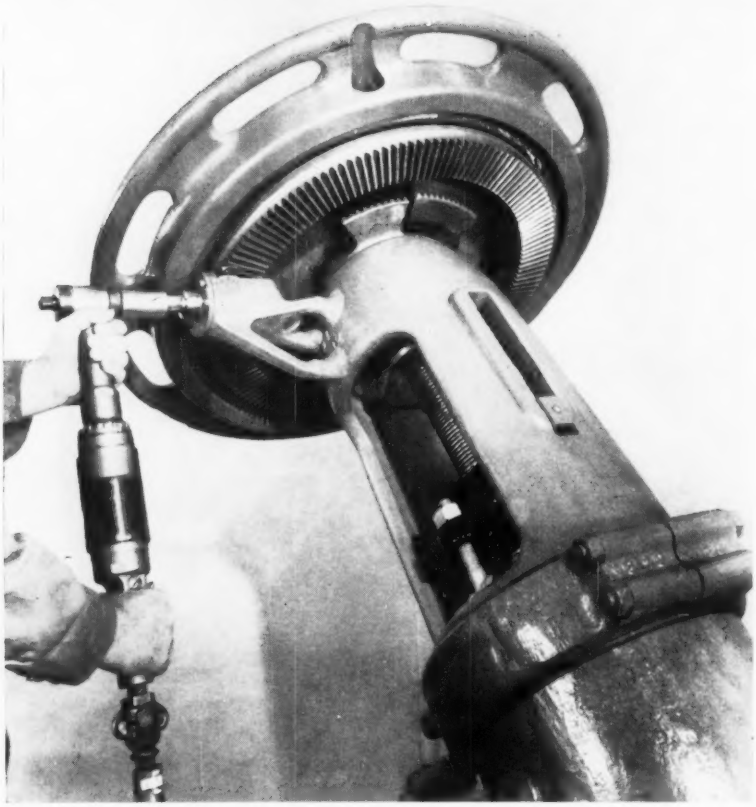


THESE SEVEN PAGES are a preview of the current issue of Edward Valve Values, published as a service to users of steel valves. In this issue:

- ★ **New taper disk throttling valve**
- ★ **Utility gets only 6-lb drop in 1860-lb line**
- ★ **Low-cost operator for large valves**
- ★ **Stop-check gives double protection at 40% saving**
- ★ **Photo tour of largest steel valve laboratory**

ABOVE — Midwest utility uses globe inlet valve (left) and globe outlet valve (right, rear) for high pressure feedwater heater connected by loop with motorized globe valve (center) so heater can be bypassed from control room to boost output. Story on following pages.

EDWARD VALVE VALUES



New Impactogear, with ring gear cover removed to show internal construction, uses compressed air to operate valve. One air outlet and associated hose with air wrench can be used on several valves in the area.

IMPACTOGEAR--A New Low-Cost Air-Operated Drive*

Operates Large Valves Quickly and Easily

- **Large, high-pressure valves can be quickly and easily operated by one man with the Impactogear operator being introduced by Edward Valves.**
- **A 10-in 2500-lb valve under pressure can easily be closed down by one man in 2½ minutes from full open to seat contact.**
- **Final tight shut-off is then achieved by the hammer-blow action of the Impactor® handwheel.**

The Impactogear is a ring gear and pinion assembly fastened to the Edward Impactor handwheel and valve yoke. A portable air wrench, operating from 90-psi plant compressed air supply, turns the pinion gear and handwheel. Impactogear is available for operation of any 10-, 12-, 14-, or 16-inch Edward valve of 900-lb or higher pressure series.

Principal advantage of the Impactogear is that it enables one man to open or run large valves down to the first Impactor blow where a crew of two to five men would otherwise be necessary . . . an advantage that becomes increasingly important as power and process plants becomes more automatic and have fewer operating personnel on each shift. As pressures and valve sizes continue to go higher, many more valves are installed that require more than one man to operate.

Increase Impacting Effectiveness 50 Per Cent

Two new design features of the Impactor handwheel — redistribution of weight and the introduction of a ball bearing — increase its impacting effectiveness over previous Impactor handwheels by 50 per cent.

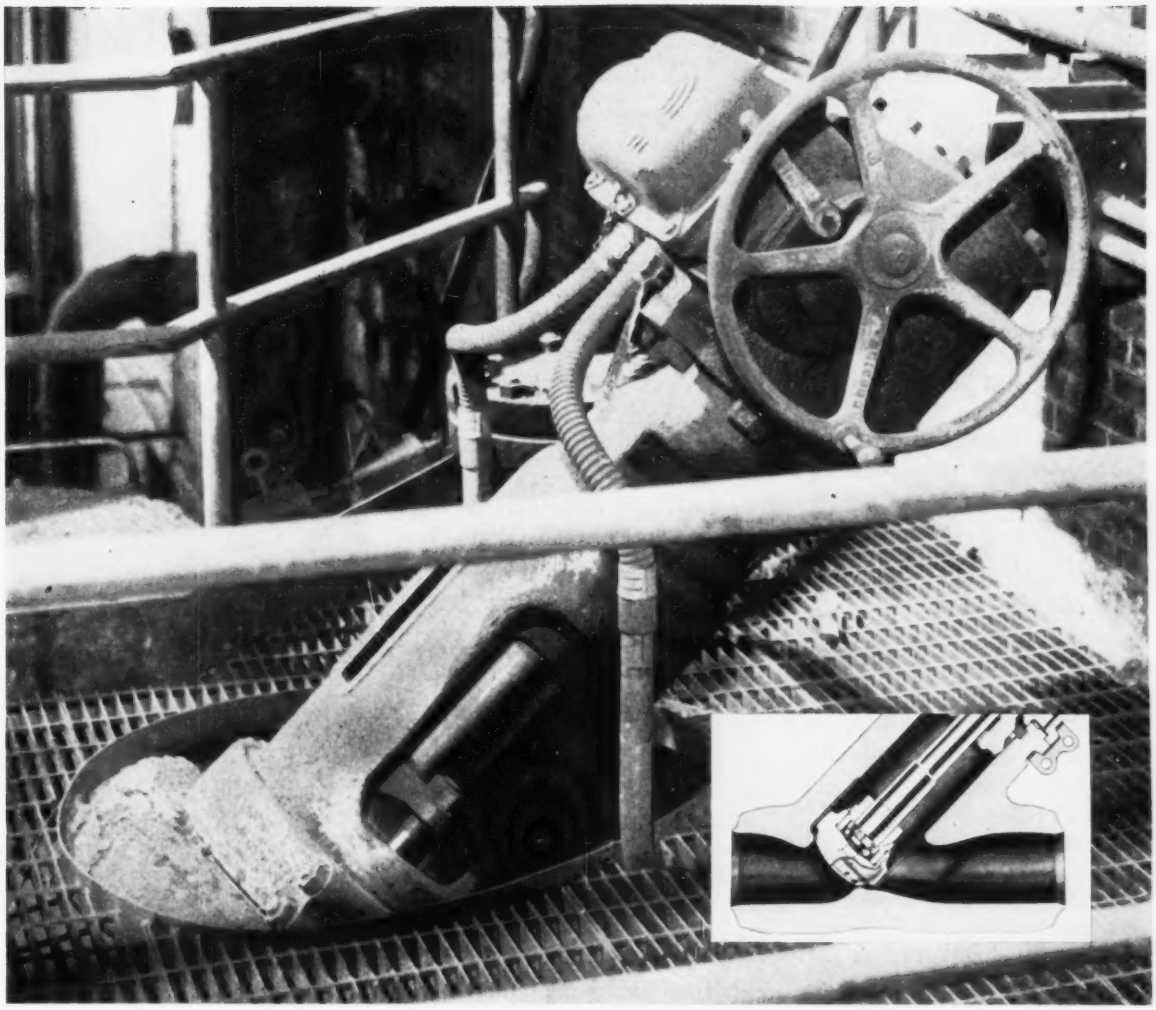
Lightweight and Low-Cost Answer

The Impactogear is a lightweight and lost-cost answer to the problem of operating large, high-pressure valves. Just one compressed air line need be run to an area where several Impactogear-equipped valves are located. One flexible air hose is attached. A portable air wrench is then put on the end of the air hose and is available to operate the several valves in the area. Selection of air wrenches depends on valve size and operating pressure. Detailed recommendations for air wrenches are available from Edward Valves.

Having one source of compressed air power is much cheaper than runing individual electric power to individual motor operators on each of several adjacent valves.

* Patent applied for.
® Reg. U. S. Pat. Off.

The Impactogear combination—gear assembly and Impactor handwheel —takes no more space than an ordinary handwheel.



New Edward Flite-Flow globe stop valve, fitted with motor operator, in main steam header, produces only 6-lb drop in 1860-psi steam at 860,000 lb/hr. Inset shows streamlined flow passages of new Flite-Flow valve.

Midwest Utility Uses Modern Globe Valve and Gets . . . Only 6-lb Drop in 1860-lb Steam Main

A prominent Midwest utility is taking advantage of a new Edward high-pressure globe valve to insure absolutely tight shutoff in its 1860-lb steam main with only 6-lb drop through the valve. The 6-lb drop is the estimated pressure loss through the globe valve at full load . . . 860,000 lb/hr at 1860 psig and 1000F.

The 6-lb drop is only 10 per cent of the total 60-lb drop between the drum and turbine throttle. Thus, this utility's experience confirms that the great advantage of absolutely tight shutoff possible with the new globe valve can be gained with negligible pressure drop.

The valve that makes possible this extremely low-pressure drop is the new Edward Flite-Flow.* This valve was specifically designed to minimize pressure drop while preserving the inherent tight shutoff of a globe valve.

All-Welded Feedwater System Uses Stop-Checks

Another modern feature of this utility's new unit is an all-welded high-pressure feedwater system, incorporating Edward stop-check valves. These valves, combining a

Continued on next page

* FLITE-FLOW IS A TRADE NAME OF EDWARD VALVES, INC.

Rockwell-Built EDWARD VALVES

angle stop valve with a piston check valve in a single body, are used in the boiler feed pump discharge lines.

The unit has three feed pumps. Two pumps are required under full load. Each pump discharge line has an Edward vertical tilting disk check valve in addition to the piston check within the stop-check valve. This double check valve arrangement gives the feed pump two types of protection against reverse rotation.

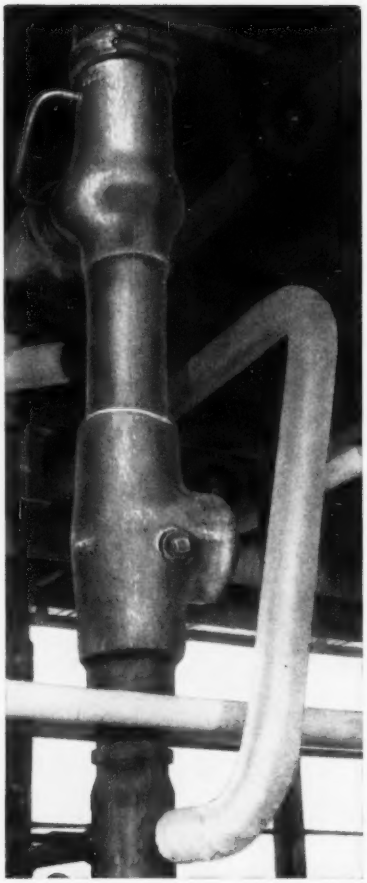
Bypass Heater For Maximum Power

Standard-rated unit output would be 125,000 kw at .86 pf and 30 lb hydrogen from 1860 psig, 1000F. To develop up to 138,100 kw, a bypass around the No. 6 feedwater heater was installed so that the energy consumed in this heater would be directly available to the turbine.

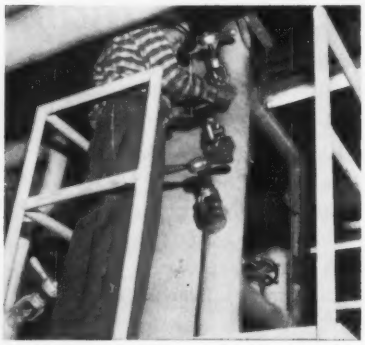
No. 6 feedwater heater is the last of six heaters in the main feedwater system. No. 1 and 2 heaters use steam from the low-pressure turbine. No. 3 heater takes steam from the crossover line between the low-pressure and high-pressure turbine sections. No. 4 heater is the deaerator, taking steam from about the middle of the reheat stage of the high-pressure turbine. No. 5 heater is a high-pressure heater taking steam from about the first third of the reheat stage of the turbine. No. 6 heater, the heater just ahead of the economizer, takes steam at 400 psig and 600 F from the cold reheat line. It is this heater that is bypassed to obtain maximum capacity.

The bypass around No. 6 heater consists of a line with a motor operated stop valve between the inlet and outlet heater valves. This bypass line parallels the heater. The stop valve in the bypass line is normally closed so that all feedwater coming to the inlet of the heater must go through it. When the motor-operated stop valve in the bypass line is opened, which can be done from the control room, the feedwater finds a path of lesser resistance around the heater than it meets going through it. The feedwater then flows around the heater, which effectively stops steam flow into it since no "cool" water is present to condense the steam. This extraction steam stops flowing to the heater for all practical purposes and is available to the turbine for the extra power that is desired.

Another reason for using the bypass would be to permit maintenance work on the heater without shutting down the boiler. At such times the Edward globe valves at the inlet and outlet of the heater, as well as the other valves in the stream lines to the heater, are closed, and the Edward bypass valve is opened.



Construction photo taken before insulation was applied to boiler feed pump discharge line shows how angle stop-check valve (above) and tilting disk check valve (below) are combined for extra pump protection.



Injection water flow is controlled by throttle valve (center), which is protected by two stop valves. Loop to rear is a bypass, with throttle valve in bottom leg. Gage valves are included in loop, too.

Check valve (rear) and stop valve (front) control 2200-psi, 430 F feedwater flowing from No. 6 heater to economizer. Angle valve bodies are used for economy in piping.

Backseat An Important Feature

Among the features of the many Edward valves in this modern power station, the backseat is considered one of the most important. In high-pressure systems, the station engineers point out, there is increased chance that feedwater chemicals may work their way into the valve packing. With good backseats, valves can be repacked under pressure.

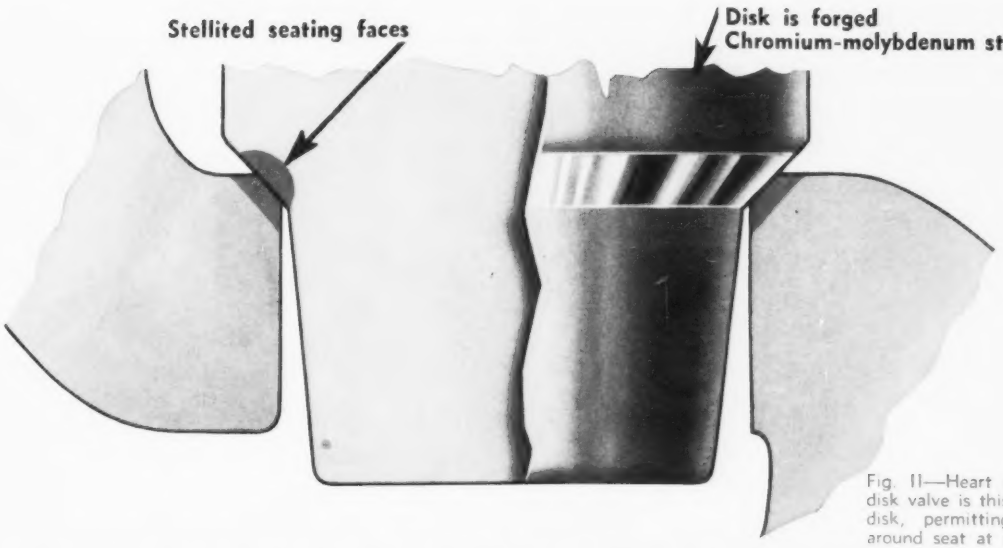


Fig. II—Heart of new throttle-disk valve is this taper profile on disk, permitting slow opening around seat at low lift.

New Taper Disk Gives Straight-line Throttle Control at Low Lift

Straight-line control of flow in the low range of disk lift is now available in Edward cast steel throttle-disk valves in sizes 2½ inches and larger. Improved control results from a new tapered disk.

As the taper disk begins to rise from the seat, the taper shape keeps the seat from opening quickly (see Fig. II). The flow area through the seat is smaller at the beginning of stem travel than in conventional stop valves and previous models of throttle-disk valves.

With constant inlet pressure, a straight-line relationship exists between flow and lift from 8 to 55 per cent lift. The steepest part of the curve (Fig. I), indicating greatest change of flow per increment of stem travel, occurs between 55 and 70 per cent of full stem travel. A straight-line relationship is approximated from 70 to 100 per cent of lift.

Expand Process Uses

Though the most common use of 2½ in. and larger throttle-disk valves has been in by-passes around boiler feedwater regulators, the comparative long life of these valves in throttling service has made them attractive for many process applications. With the improved flow-lift characteristics of the taper disk, process applications seem even more attractive.

Throttle-disk valves in feedwater regulator by-passes may be used once, twice or three times a year . . . whenever the automatic regulator cannot be used and manual regulation is necessary. But in process applications typical of those now in use, throttling may be required several times a day.

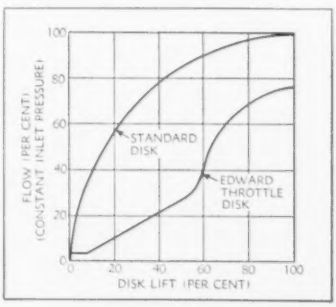
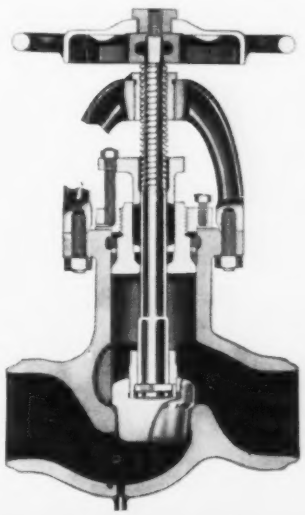


Fig. I—New throttle-disk gives good linear control at low lift and high capacity at high lift.

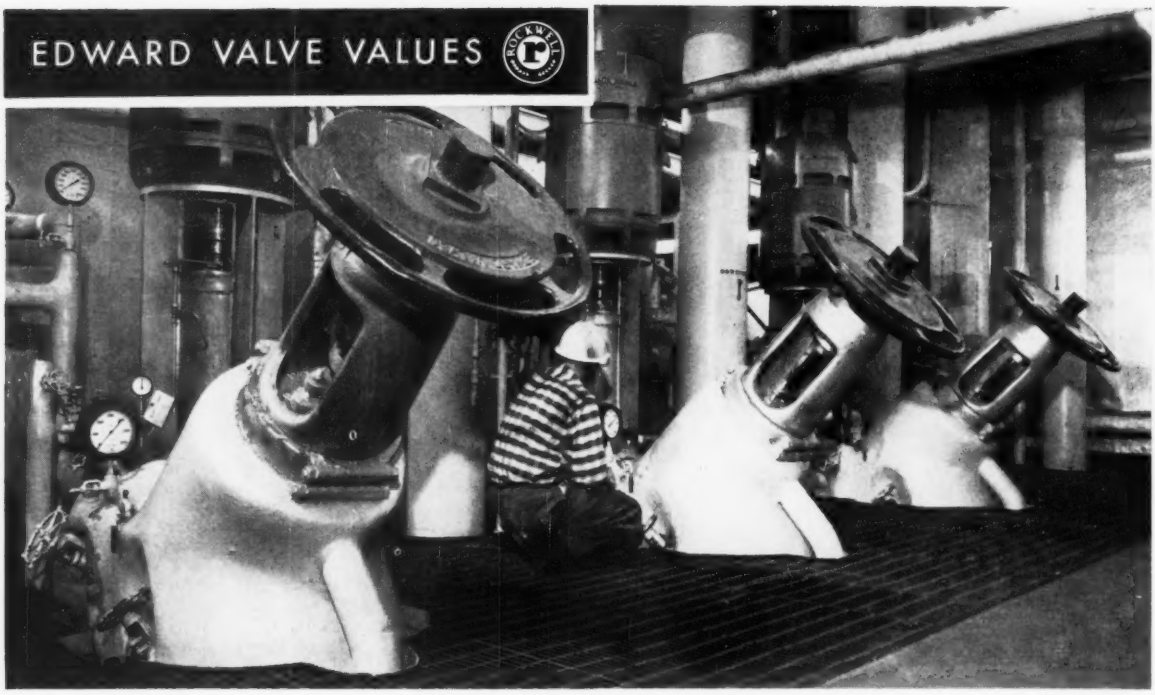
Throttle-disk valves, being designed for use in place of ordinary stop valves wherever heavy throttling duty is expected, are preferable whether for feedwater or steam lines. The new tapered disk in Edward throttle-disk valves adds the advantage of straight-line flow control in important ranges of operation.



Typical 4-inch throttle-disk forged steel valve is similar to conventional globe valve.

Rockwell-Built EDWARD VALVES

EDWARD VALVE VALUES



Typical of cost savings possible by use of stop-checks instead of separate stop valves and check valves is this installation of stop-check valves on discharge lines of circulating pumps on controlled circulation boiler.

Stop-Checks Give Double Protection And Cut Valve Costs 40 Percent

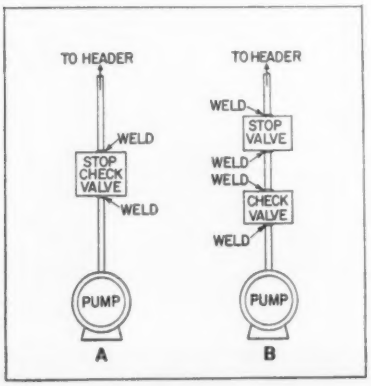
Stop-check valves in boiler feedwater systems offer the advantage of adding a check valve for very little more cost than a plain stop valve. Using typical Edward prices for comparison, we find that a stop-check valve costs about 10 per cent more than a plain stop valve, while a separate check valve may cost 70 per cent of its associated stop valve.

For example, $70 must be spent for a check valve for every $100 spent on the adjacent stop valve if a separate check valve is used. But if a stop-check valve is used in place of separate valves, only $10.00 needed be added to every $100 that would have been spent on the stop valve. The check valve can be had for only 10 per cent more than the price of the stop valve when the two valves are combined. Furthermore, as much as $20 more per $100 of stop valve can be saved because the two welds for the separate check valve are eliminated by using a stop-check valve.

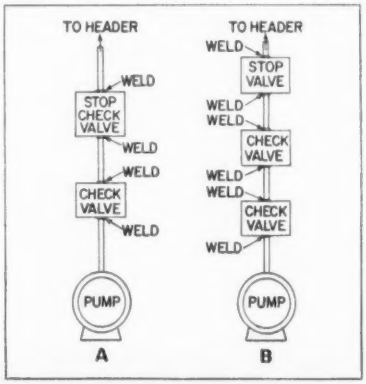
Let's look at the valves required for two most common boiler feed pump discharge line hookups

CASE I: Assume that one check valve and one stop valve are to be installed. Setting up costs on the basis of each $100 spent for the stop valve, we find:

Stop valve	$100		
Check Valve	70	Stop-check valve	$110
Four welds	40	Two welds	20
	$210		$130



Case I: Stop-check saves one check valve and two piping welds . . . about 40 per cent.



Case II: Stop-check valve saves one check valve and two welds . . . about 23 per cent.

CASE II: Assume that two check valves are specified, to give a higher degree of protection to the boiler feed pump against reverse flow. That is, at least one check valve should operate if the other check

valve should malfunction.

Stop valve	$100	Stop-check valve	$110
Two check valves	140	One check valve	70
Six welds	60	Four welds	40
	$300		$220

Thus, the stop-check valve cuts the cost of feed pump discharge valving by about 40 per cent with one check valve in the line and by 26 per cent with two check valves in the line.

Preserve Isolating Function

What does this mean operationally? With one check valve in the line, the stop valve is usually placed between the check valve and the feedwater header. With this arrangement or with the substitution of a stop-check valve, the individual feed pump can be isolated from the header for repairs and maintenance or for hydrostatic tests.

With two check valves in the line, the stop-check would be placed between the separate check valve and the feedwater header. Again, the isolating function of the stop valve is preserved. But, a further advantage arises out of using the stop-check in addition to the costs saved.

Two Types Reduce Hazards

This added advantage follows from the fact that the stop-check valve inherently is a piston check valve as far as the checking function is concerned. This means that the other check valve can be of another type.* Thus, any line condition likely to cause malfunction of one type of check valve affects only one of the two check valves in the line. This condition is not likely to affect the other check valve because each type of check valve has its own vulnerabilities. So, in addition to the double protection of two check valves as such, there is additional protection because the conditions that may cause malfunction in one check valve are not likely to cause malfunction in the valve of another type. Statistically, there is a better chance of obtaining check valve action when it is needed.

Many engineers have long desired to install two check valves in boiler feed pump discharge lines, but have been deterred by the extra cost. There was some doubt that the extra cost could be justified by the risk, though some few utilities have already standardized on two check valves. But by using a stop-check valve instead of the ordinary stop valve that is needed anyway, the advantage of two check valves is obtained with less than 10 per cent added investment . . . instead of more than 40 per cent if a stop valve and two check valves are installed.

* See illustration, upper right, page 60

Take Photo Tour of World's Largest Steel Valve Laboratories

The world's largest research and experimental laboratories devoted exclusively to steel valves are described in a new four-color 32-page booklet now available from Edward Valves. Using the techniques of a photo tour, the booklet shows how valve research is carried on through flow studies, stress analysis, accelerated temperature tests, radiographic and other inspections, nuclear flow loop tests, aging procedures, packing studies, foundry investigations, and basic metallography.

The new booklet explains why research is necessary in making valves, pointing out that service conditions have changed tremendously in the fifty years that Edward Valves has been in business. It shows how 40 years of service at rated temperature and pressure is duplicated in the laboratory. Over a quarter-million gamma-ray negatives now on file were taken with equipment such as shown in this booklet. Devices are described that detect leakage as minute as one teaspoonful in 30 years.

Copies of the new booklet describing the Edward Research and Experimental Laboratories are available on request. Just fill in and mail the coupon below.

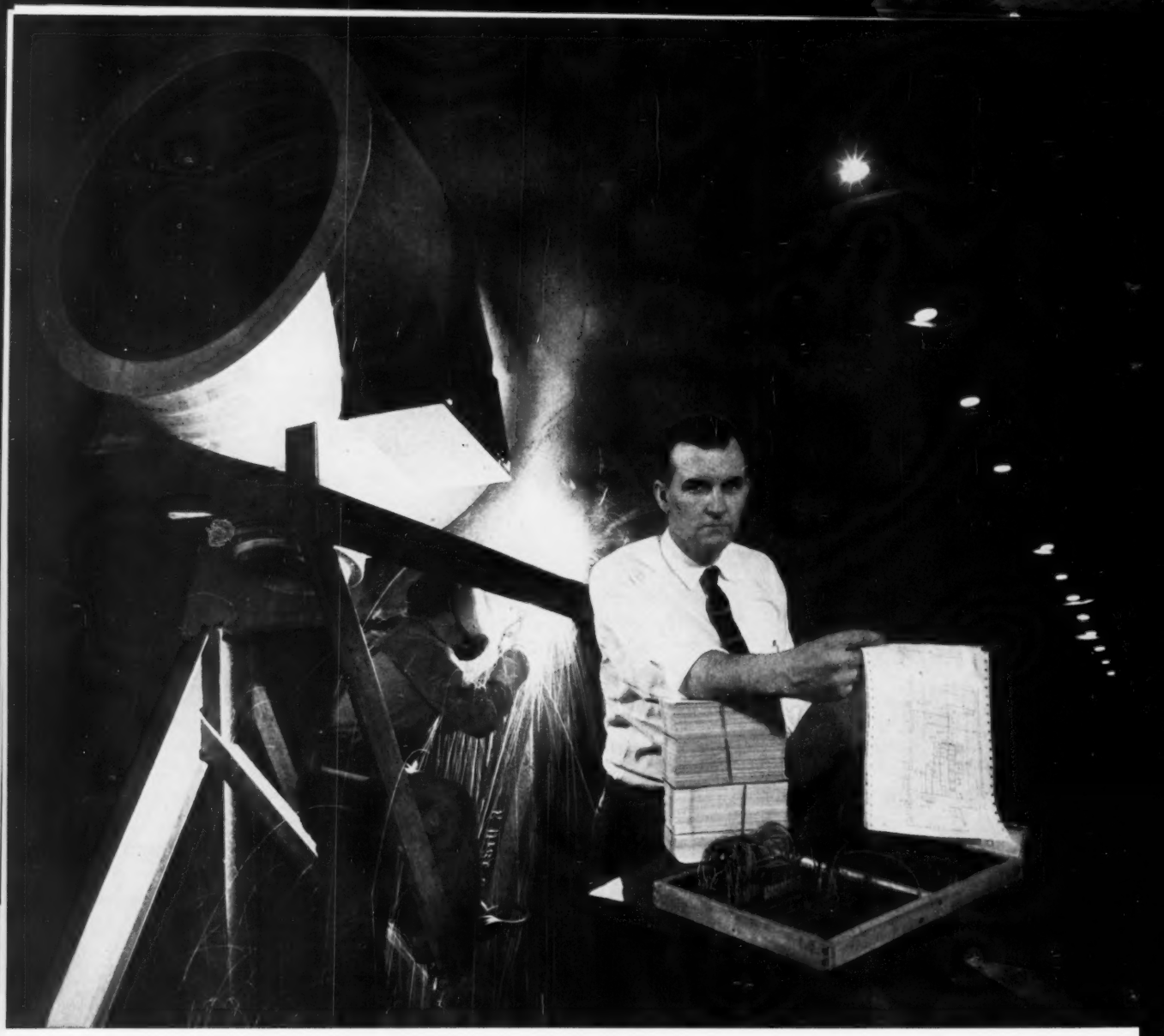
The EDWARD Research Laboratories

EDWARD VALVES, INC.
Subsidiary of
ROCKWELL MANUFACTURING COMPANY
1230 West 145th Street
EAST CHICAGO, INDIANA

EDWARD VALVES, INC.
Subsidiary of
Rockwell Manufacturing Co.
1230 WEST 145th STREET,
EAST CHICAGO, INDIANA

Send information about the following:
- ☐ Edward Research Laboratories (New Booklet)
- ☐ Impactogear Operator
- ☐ Flite-Flow Valves
- ☐ Throttle Disk Valves
- ☐ Full Line

Name_____ Title_____
Company _____
Address _____
City_____ Zone_____ State_____



Automatic data processing, applied to the many variables of thermal design, results in higher efficiency of ALCO *feedwater heaters.*

HOW DO YOU FIGURE A FEEDWATER HEATER?

The trend to higher pressure and temperature in utility and industrial power plants demands *exact* design of feedwater heaters for the best heat-rate economy. ALCO, a 30-year pioneer in the heat transfer field, is again pacing the industry by focusing thermal engineering on solutions to this problem.

Advanced data on heat transfer and fluid flow from ALCO's new thermal laboratory, programmed through new electronic digital and analog computers, permits ALCO to offer the most accurate feedwater-heater thermal designs available today. Already in service and on order for the country's most efficient steam-generating plants, these heaters are proving their economy and reliability.

For more information, contact your nearest ALCO sales office or write for brochure on feedwater heaters to: ALCO Products, Inc., Dept. 132, Schenectady, New York.

ALCO

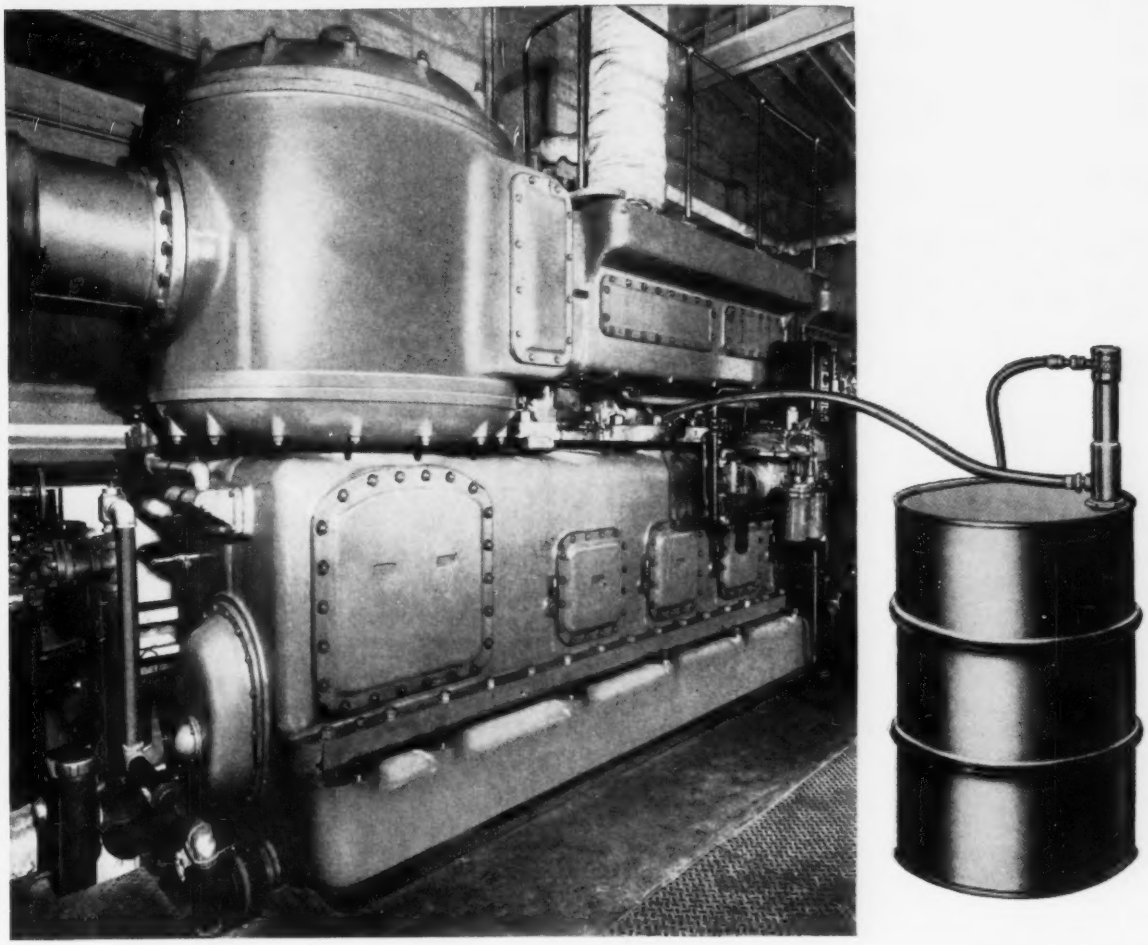
ALCO PRODUCTS, INC.

NEW YORK

SALES OFFICES IN PRINCIPAL CITIES

Locomotives · Diesel Engines · Nuclear Reactors · Heat Exchangers · Springs · Steel Pipe · Forgings · Weldments · Oil Field Equipment

Varnish Problem Vanishes!



Stop the formation of harmful **varnish,** sludge and carbon in your Diesels and *keep it stopped* with Sinclair RUBILENE® or RUBILENE HD, the high viscosity index oils proved by over 35 years in industrial Diesel applications. RUBILENE earns its reputation by its performance under continuous operation and heavy loads. It fights deposits and gives better protection to cylinders, pistons, rings and other vital moving parts. Your Diesel stays on the job longer . . . service time is cut 'way 'way down.

Let RUBILENE help solve *your* lubrication problems. Regardless of the make of your Diesel, there's a member of Sinclair's RUBILENE or RUBILENE HD family that meets your requirements. Call your local Sinclair Representative for further information, or write for free literature to: Sinclair Refining Company, Technical Service Division, 600 Fifth Avenue, New York 20, N. Y. *There's no obligation!*

Dino, the Sinclair Dinosaur, says:

"Send now for free literature on RUBILENE!"

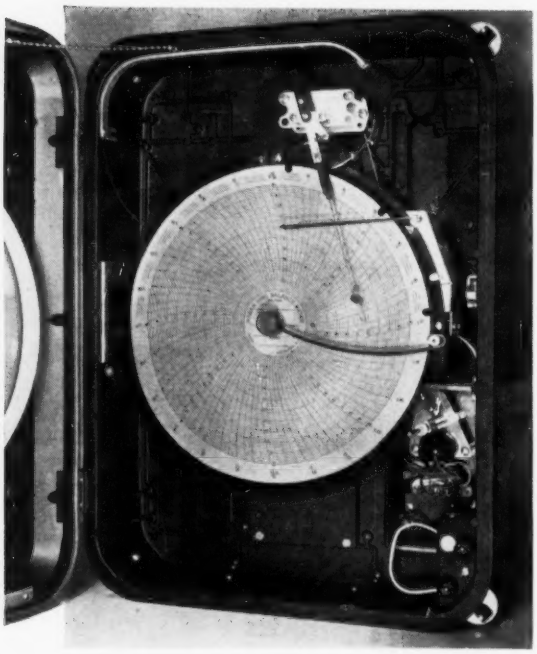
SINCLAIR RUBILENE® OILS

RING BALANCE FEATURES No. 4

ELECTRIC TRANSMISSION

with the versatile new PowrLog

ELECTRONIC RECEIVER



Complete assembly with amplifier in place. Flow integrator may be added for complete records.

The Hagan PowrLog Electronic Receiver brings a new standard of accuracy and dependability to the remote transmission of all standard variables. In applications where the transmitter is a Ring Balance meter equipped with slide wire, the PowrLog receiver can record, integrate and indicate fluid flow with or without compensation for pressure and temperature, fluid density, liquid level in open or closed vessels, boiler drum water level. Used with suitable amplifiers, the field of application widens to include temperature, heat exchange and other variables.

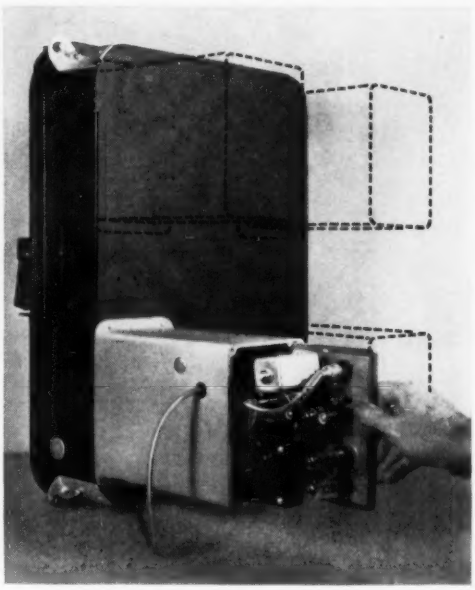
Interchangeable, plug-in, input boxes quickly adapt the PowrLog to operation with AC or DC inputs. Up to four records can be made simultaneously or control can be accomplished through coupling to the Ring Balance pneumatic transmitter-controller.

Unaffected by mechanical friction or power supply fluctuations, the PowrLog offers these operating characteristics:

Resolution	0.15% of full scale
Repeatability	0.25% full scale
Over-all Accuracy	0.5% full scale
Pen Travel Time	2 seconds full scale (0.5 sec./inch)

Input Ranges:

AC Bridge	1000 ohm transmission potentiometer
DC Potentiometer	0-0.1 v. to 0-1.3 v.
DC Voltmeter	500 volts maximum



Printed circuit amplifier chassis slides readily into housing. Note that as many as four units may be used in a single instrument case.

Remember, the Hagan Ring Balance meter offers you all these features, too:

1. Ease of calibration under operating static pressures with factory calibrated check weights matched to each meter. No more four-story water columns and telephones!
2. Safe operation with rings rated at 2,500, 6,000, 15,000 psig. No gaskets, no stuffing boxes.
3. Sealing fluid density and level not critical. No eyedroppers required to maintain calibration.
4. Interchangeable ring assemblies for full scale ranges from 0.5" w.c. to 560" w.c. Adjustment on any one ring over a 7:1 differential range easily and quickly accomplished.
5. Wide range computation and/or compensation by means of built-in, easily checked mechanisms available on most models.
6. Any Ring Balance meter can be equipped with slide wire for operation with data-logging devices and for transmission to the PowrLog.

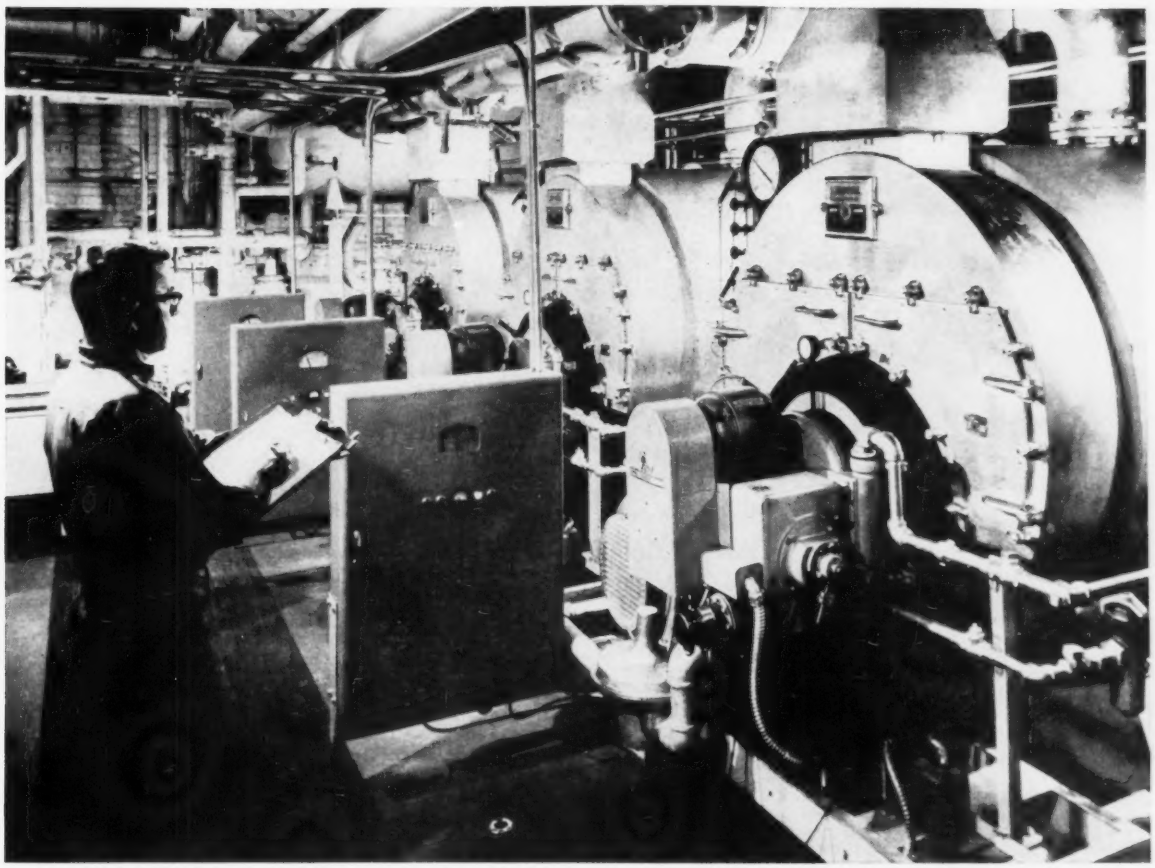
For full details on the Hagan PowrLog, write for Bulletin MSP 149.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

The smart way to modernize

. . . specify your heating plant in one package



This remodeled boiler room serves the two buildings of the Columbus Dispatch newspaper plant, Columbus, Ohio. Fuels can be quickly changed in these three Iron Fireman-Kewanee gas-oil boiler-burner units. Consulting Engineers, John Paul Jones, Cary & Millar, Cleveland; Architect, Dan A. Carmichael, Columbus; Heating Contractor, Limbach Co., Columbus.

Iron Fireman burner with boiler — engineered as a single unit

These famous boiler-burner units are the products of two great specialists—each in its own field. They are engineered for each other. Included in one catalog, they can be ordered by a single model number from one set of specifications.

Plenty of reserve power

You can feel *safe* in specifying Iron Fireman equipment. These thoroughly engineered units are conservatively rated. The normal firing rate is a comfortable cruising speed—less strain, low maintenance, quiet operation, higher efficiency —and that big extra capacity is always standing by to pick up extra loads.

Compact and complete

These complete steam or hot water generating units require little more than service connections. Automatic controls, air and fuel systems are built in. No special boiler settings; low headroom; no high stack.

Please mail coupon for catalog and specifications.

IRON FIREMAN®

AUTOMATIC FIRING EQUIPMENT
FOR OIL, GAS, COAL

IRON FIREMAN MANUFACTURING CO.
3036 West 106th Street, Cleveland 11, Ohio
(In Canada, 80 Ward Street, Toronto, Ontario)

Please send catalog and specifications on following equipment:

☐ Complete boiler-burner units
☐ Forced draft firing unit only

Name_____

Firm_____

Address_____

City_____ State_____

GILSULATE® Pipe Insulation Digest

FOR UNDERGROUND HOT PIPES

Analyze costs of seven insulation systems

Case Tech chooses Gilsulate

When one of the nation's top technical schools selects your product after long laboratory and field tests you have a right to be proud.

We're doubly proud of Gilsulate: it's been chosen by Case Institute of Technology in Cleveland as the underground hot pipe insulation for its major expansion program—and for rehabilitation of all steam distribution systems on the campus as the need arises.

Case is only one instance of major Gilsulate installations at leading schools, colleges, training centers and other large institutional centers. You will also find Gilsulate protecting underground hot lines in every type of industry, in all parts of the country.

The trend is to Gilsulate. Write for complete details and learn why.

300-FOOT REPLACEMENT LINE going in at Case. Note forms around pipe to conserve Gilsulate.

GILSULATE IS THE SIMPLEST TO INSTALL of any underground hot pipe insulation. An illustrated wall chart, "How To Install Gilsulate," showing the 10 simple steps to follow, has been prepared. We will be glad to send you a copy on request.

How to select underground hot pipe insulation

There are at least 11 important points to look for in choosing insulation for underground hot piping systems. Users' experience with Gilsulate and other insulations under all and varied conditions proves that Gilsulate can out-perform all others. The 11 points are:

1. High resistance to both conductive and radiant heat flow.
2. Stable and non-corrosive in air, acid and alkaline soils, and salt water.
3. Good dielectric.
4. Moisture-proof and vapor-proof *without* jacketing or sealing.
5. Uses readily available materials both in manufacture and installation.
6. Easy and rapid to install, with a minimum of skill and effort.
7. Structural stability under vibration, dead and live loads, during shipping, storage, installation and operation.
8. Adaptable through a wide range of temperatures.
9. Allows pipe to expand and contract.
10. Allows system to be repaired and altered easily.
11. Allows piping leaks to be detected readily.

Gilsulate costs less per installed linear foot than *seven* different types of underground distribution systems, according to a report given by R. D. Hummel at the annual meeting of the National District Heating Association. Mr. Hummel is Manager, Division of Engineering, Yale University.

Based on installations of 1,000 feet of 8-in. welded steam line, and 4-in. welded return, Gilsulate costs $27 per linear foot, including the pipe, digging and insulation. The table below lists the systems compared, and costs.

System	*$Cost/ft.*
Gilsulate	27
Product A, with concrete fill	32
Tile conduit; pipe insulated with magnesia, and wrapped	32
Pipe insulated with magnesia and having metal jacket with protective coating	32
Reinforced concrete pipe over concrete slab, with wrapped magnesia insulated pipe	35
Precast slab envelope with magnesia insulated pipe within	42
Walk-through tunnel with magnesia insulation on lines	120

Here again is convincing proof that poured-in-place Gilsulate drastically cuts underground hot pipe insulation costs, with top corrosion protection and thermal efficiency. Gilsulate's high resin content, water-repellent properties, resistance to all corrosive elements normally found in soil, and high insulating value are unique. No wonder Gilsulate is the ideal—and most economical—solution to underground hot piping insulation problems!

Note: A complete account of Mr. Hummel's talk will be found in the Spring 1957 issue of PIPE INSULATION NEWS, available on request.

American Gilsonite Company

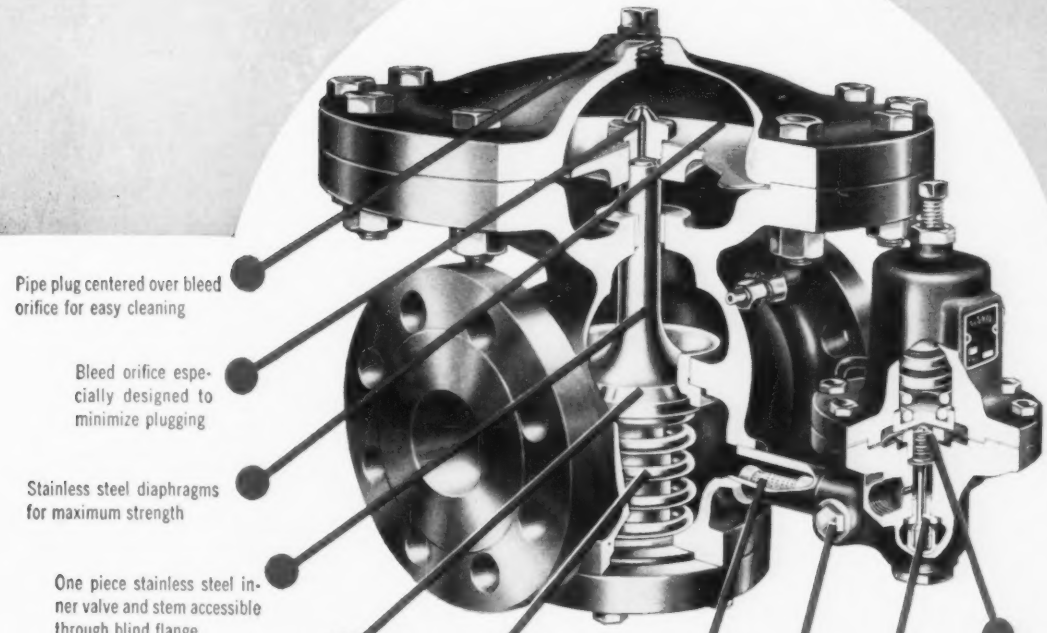
134 West Broadway, Salt Lake City 1, Utah
Eastern office: 3537 Lee Road, Cleveland 20, Ohio
Distributors in principal countries of the world
Affiliate of Barber Oil Corporation and Standard Oil Company of California

All of these items appeared in PIPE INSULATION NEWS. To keep abreast of money-saving hints and developments in underground hot pipe insulation, ask to be put on our mailing list.

THE FISHER® 92B

IMPROVED

TO MINIMIZE PROBLEMS INHERENT IN STEAM SERVICE


Pipe plug centered over bleed orifice for easy cleaning
Bleed orifice especially designed to minimize plugging
Stainless steel diaphragms for maximum strength
One piece stainless steel inner valve and stem accessible through blind flange
Stainless steel seat ground at 60° angle
Inconel valve spring resists corrosion and stress relieving
Removable brass strainer screen to protect pilot valve seat
Pipe plug for easy strainer flushing
Pilot valve seat of hardened stainless steel
Bronze bellows seals downstream pressure from loading pressure

Not content with the enviable performance record of the Type 92A, Fisher engineers have improved this pilot operated pressure reducing valve to a new peak of performance.

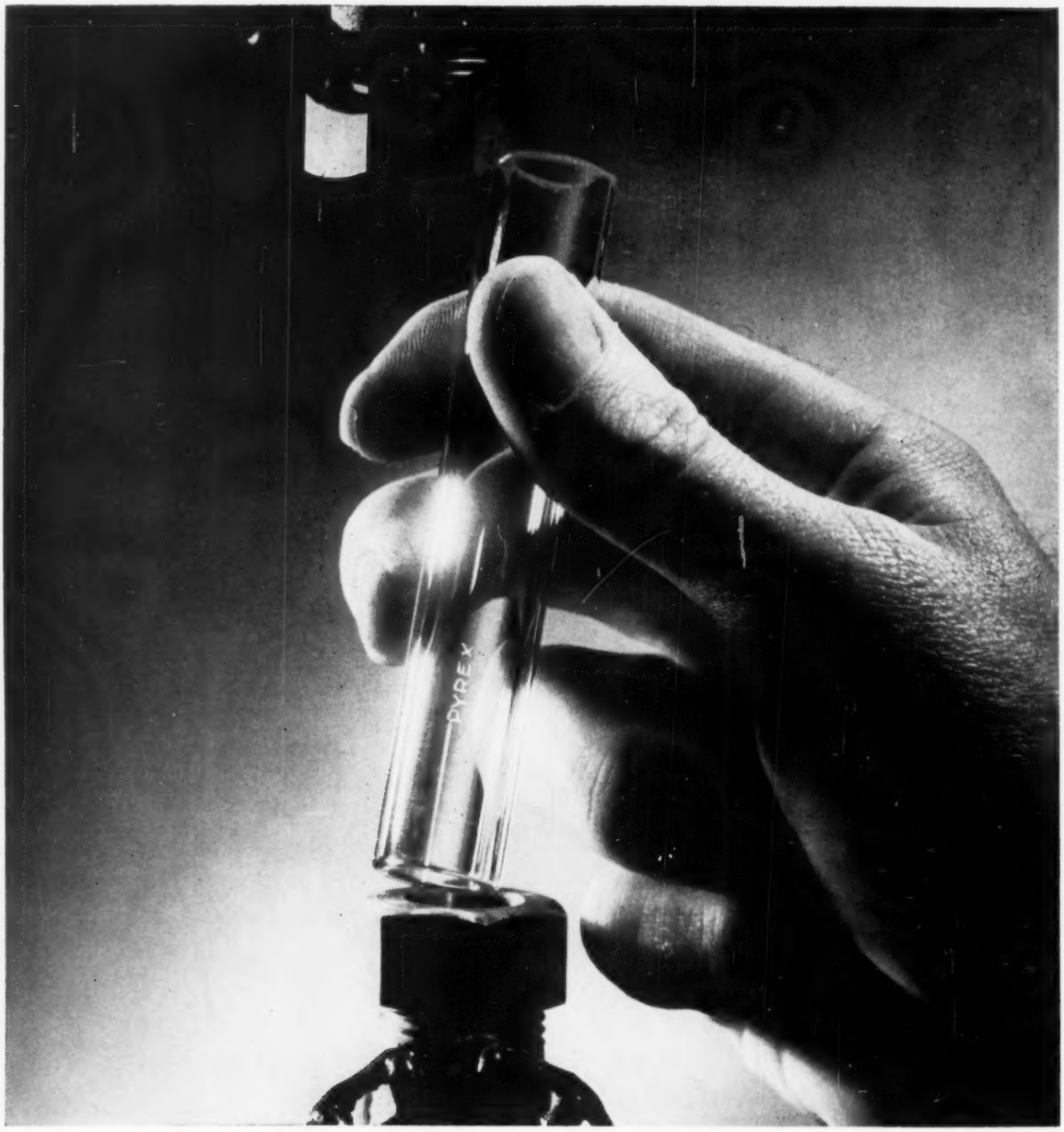
For extremely accurate, long trouble-free service, put a Fisher 92B in the line. One pilot with three interchangeable springs provides a range of from 2 to 150 psi. • *Send for Bulletin D-92 today.*

Engineers with special problems . . . find the ***answer*** *in . . .*

FISHER GOVERNOR COMPANY

Marshalltown, Iowa / Woodstock, Ontario

FISHER® Controls



A gauge glass installed... and two more on the shelf

Make short work of gauge glass replacement—when the replacement is as near as your stockroom shelves. You'll cut down time.

Take *three* gauge glasses the next time you order from your distributor. That gives you *one* for the gauge right away, a *second* for regular replacement, a *third* to cover special emergencies.

And here's another tip—don't rely on any old type gauge glass. Insist on regular replacement with PYREX®, CORNING®, or MACBETH® to avoid trouble.

These gauge glasses last longer—because they're harder to break! They stand up better to just about every clouding hazard. They easily resist high temperatures and high pressures.

One of these brands is just right for your gauge. Get some from your regular mill supply dealer. And remember—ask for *three* for each gauge!

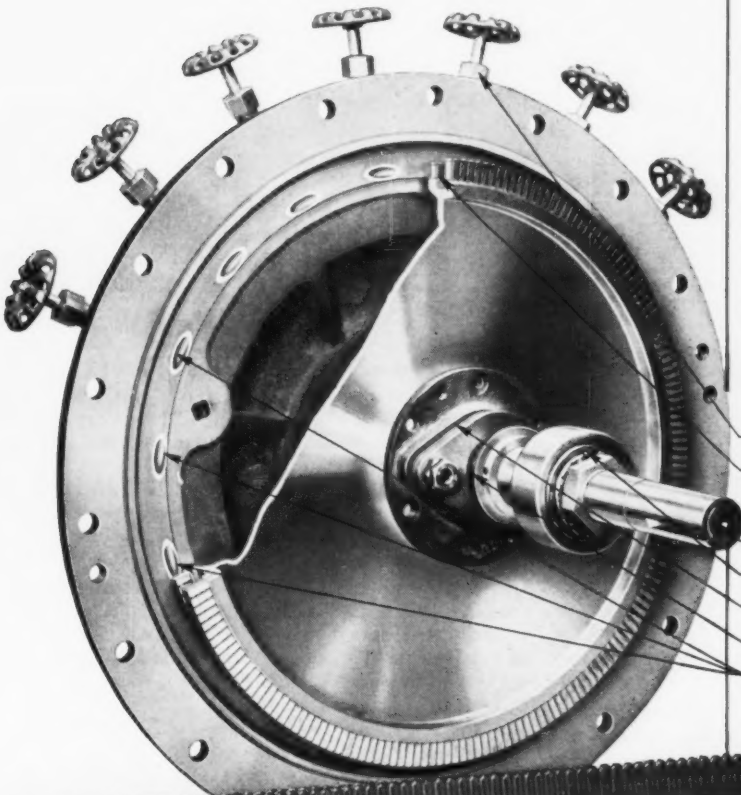
(Corning makes sight glasses, too—from tough PYREX brand glass. Use them whenever you must see what's going on inside your processing equipment. Your distributor has them.)

Corning means research in Glass **CORNING GLASS WORKS, Corning, N. Y.**

No other steam turbine offers you

SUCH VERSATILE STEAM NOZZLE CONTROL

The larger number of hand valves you see on a Coppus Steam Turbine promises you greater operating economy. At least 60% of the steam nozzles can be individually controlled to give maximum steam pressure in steam chest . . . a guarantee of best water rates at any load. Maintenance economy, too, is assured by the hard chromium plating of the shaft at the stuffing box. It provides the best possible smooth, non-corrosive surface for packing rings.



7 hand valves for efficient partial load operation, (20" turbine shown)

2 row velocity-stage turbine wheel with stainless steel turbine buckets — statically and dynamically balanced

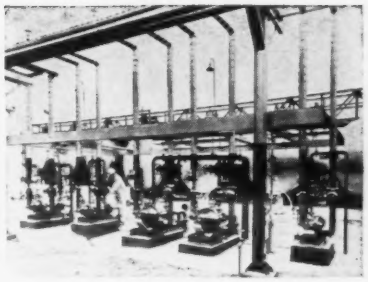
30-40 carbon steel shaft

Oversized double row deep grooved ball bearing

Stuffing box with metallic packing ring

Heavy chrome plating of shaft through stuffing box

3 nozzles always open



Coppus Steam Turbines, Type TF, driving chemical transfer pumps at Celanese Corporation of America's Chemcel Plant

Coppus Steam Turbines ranging from 150 hp down to fractional in 6 frame sizes

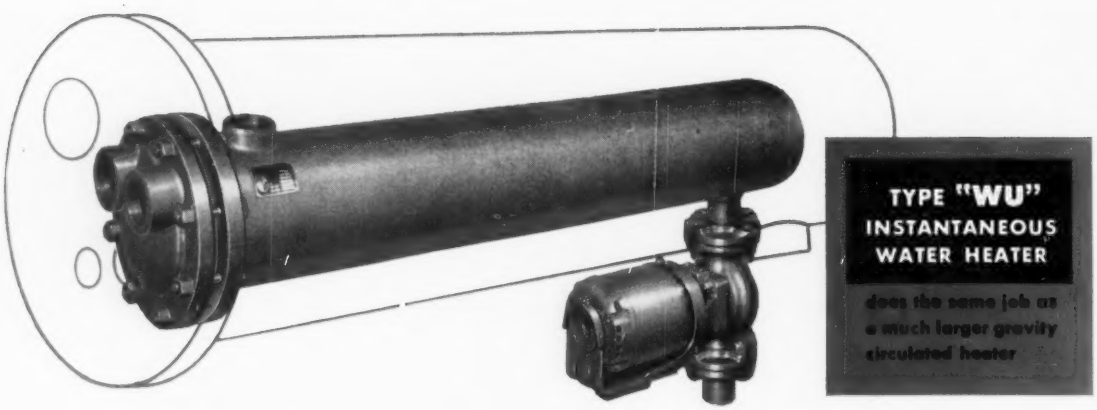
MAKE TURBINE DOLLARS GO FARTHER

Why waste money buying turbines with higher horsepower ratings than you need? The higher the horsepower rating, the higher the price. Save money by selecting the Coppus Turbine size closest to your requirements from 150 hp down to fractional. And when you do, you save operating and maintenance costs, too. That's what these other Coppus features are designed to do: exclusive pilot operated excess speed safety trip supplementing constant speed governor; choice of metallic or carbon ring packing assemblies. Designs available for back pressures up to 75 pounds; replaceable cartridge type bearing housings. For full details . . .

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORP., 163 Park Avenue, Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES



PRODUCES *MORE HOT WATER*...SAVES SPACE...SAVES MONEY

Pumped boiler water circulation steps-up capacity...permits close temperature control

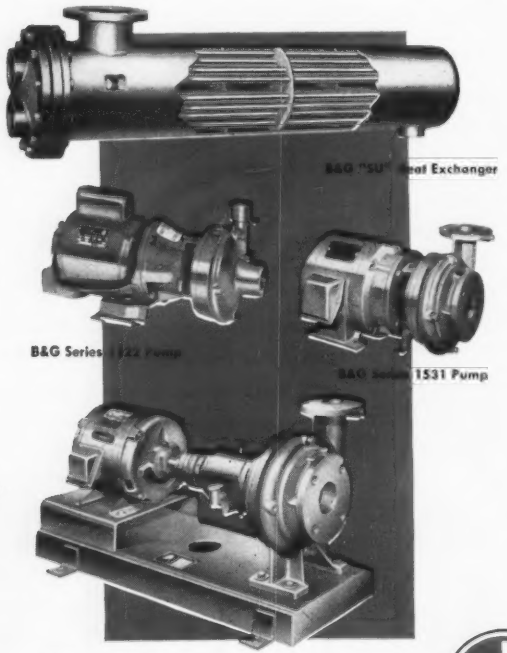
This B&G Heat Exchanger offers three important advantages—

1. More hot water from a smaller unit. The "WU" comes equipped with a B&G Booster Pump which pumps boiler water through the baffled shell, greatly increasing the capacity of the heater. Large volumes of hot water are produced by amazingly small units.

2. Controls water temperature. The Booster is controlled to start whenever water temperature goes below the desired degree. Boiler water is pumped through the shell of the "WU" until service water is again at the correct temperature.

3. Cuts installing cost. Because of pumped circulation, the smaller piping and fittings required materially reduce cost...cutting and threading can be done on the job. No storage tank needed.

"WU" Heat Exchangers can be installed on hot water boilers or below the water line of steam boilers.



B&G Series 1510 Type B Pump

FAST DELIVERY

ON PUMPS AND HEAT EXCHANGERS FROM FACTORY STOCK ON HAND*

A comprehensive stock of most commonly used sizes of heat exchangers and pumps is maintained at the factory —ready for immediate delivery. Your local distributor or B&G Representative will be glad to assist in selecting the proper unit for your needs. Or, write, phone or wire the Bell & Gossett factory at Morton Grove, Illinois.

B&G Heat Exchangers are products of over a quarter century's experience in heat exchange design...manufactured under constant supervision to ASME Code. B&G stock Centrifugal Pumps are distinguished by vertical split-case design...bronze-fitted construction...non-overloading motors and leak-proof "Remite" mechanical seals. They can be serviced without disconnecting pipe lines or motor leads.

Send for catalogs of B&G Heat Exchangers and Centrifugal Pumps.

*Do you receive our Monthly Availability Report on B&G Heat Exchangers? If not, send your name.

BELL & GOSSETT

COMPANY

Dept. FE-36, Morton Grove, Illinois

Canadian License: S. A. Armstrong Ltd., 1400 O'Connor Drive, Toronto 16, Ontario

Esso's 80,000 lbs of Alcoa Aluminum jacketing (alloy 3003 sheet) gives all-weather, year-round protection to one 20-in. high pressure steam line . . . two 30-in. low pressure steam lines . . . one 16-in. low pressure line, two 8-in. steam-traced fuel oil lines.

Designed by Esso engineers and several consulting firms, the pipeline system joins Bayway Refinery facilities with the Linden generating station of the Public Service Electric and Gas Co. Jacketing was applied by the Trybee Co., Inc., Garfield, New Jersey.

Corrosion-resistant Alcoa Aluminum Pipe Jacket helps Esso save $500,000 annually

Light, bright, corrosion-resistant jacketing of ALCOA® Aluminum helps Esso Standard Oil Company save over $500,000 annually. Installed on 5½ miles of large diameter, steam-carrying pipe at the company's Bayway, New Jersey refinery, the aluminum jacketing shields the piping and its insulation from rain, snow, dirt and ice . . . while providing highly effective protection against an industrial-marine atmosphere.

Esso estimates that the insulation with its protective aluminum jacketing has cut pipeline heat loss to just 5% of that experienced with bare pipe. In a year's time, over $500,000.00 would be needed to replace heat lost without such protection. The aluminum jacketing keeps the insulation fully effective by guarding it against weather damage.

Like Esso, you will reap handsome dividends through effective insulation protection and reduced corrosion damage . . . by jacketing your insulated pipelines with light, bright, corrosion-resistant ALCOA Aluminum. For full information, use the coupon or write ALUMINUM COMPANY OF AMERICA, 888-C Alcoa Building, Pittsburgh 19, Pennsylvania.

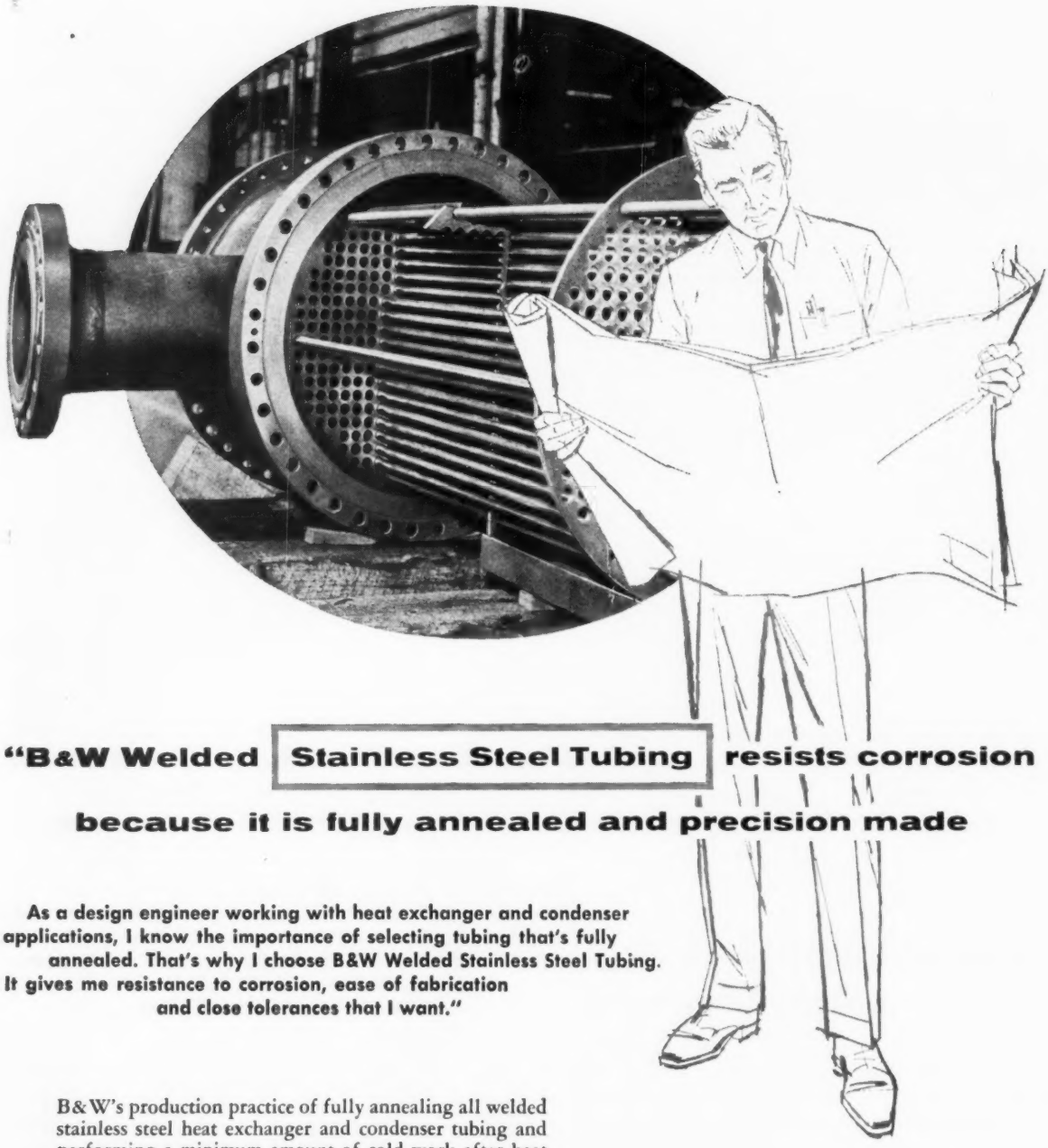
ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

"ALCOA THEATRE"
Exciting Adventure
ALTERNATE MONDAY EVENINGS

Aluminum Company of America
888-C Alcoa Building
Pittsburgh 19, Pennsylvania

Please send me full information on corrosion-resistant Alcoa Aluminum Pipe Jacketing for the following piping services:

Name
Company Title
Address
City Zone State



"B&W Welded Stainless Steel Tubing resists corrosion because it is fully annealed and precision made

As a design engineer working with heat exchanger and condenser applications, I know the importance of selecting tubing that's fully annealed. That's why I choose B&W Welded Stainless Steel Tubing. It gives me resistance to corrosion, ease of fabrication and close tolerances that I want."

B&W's production practice of fully annealing all welded stainless steel heat exchanger and condenser tubing and performing a minimum amount of cold work after heat treatment achieves the ideal condition of maximum general corrosion resistance and close size tolerances. This provides ease of fabrication and threading of tubing through baffles and tube sheets and minimizes the possibility of failures in service due to combinations of stress and corrosion.

For further information, call Mr. Tubes, your nearest B&W representative—he can help you solve any tubing problem—or write for Bulletin TB-415. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W

TUBULAR PRODUCTS DIVISION

TA-8007-PG-2

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals.

LOUIS N ROWLEY, EDITOR • MARCH 1958 • ESTABLISHED 1882 **Power**

Growth of an Idea

Back in 1955, when a concerted drive was begun on the problem of inadequate residential wiring, our staff conferences pointed up the importance of a parallel program in industry.

Field checks and meetings with leading industrial engineers, consultants and manufacturers confirmed these facts: (1) Many of today's manufacturing plants find production hindered by inadequate electrical facilities. (2) Even more important, many in-plant electrical systems being built or modernized now will soon feel the pinch because shortsighted planning failed to give them the capacity and flexibility to meet bigger future loads economically.

So in September, 1956 we launched a significant editorial program—the Power to Grow . . . *electrically* program. Since that time, each issue of POWER has carried this program forward, with special articles designed to make engineers and management aware of the need for *power to grow*, and to show how to build *power to grow* into each part ot the in-plant electrical system, from the primary substation to the point of application at the load.

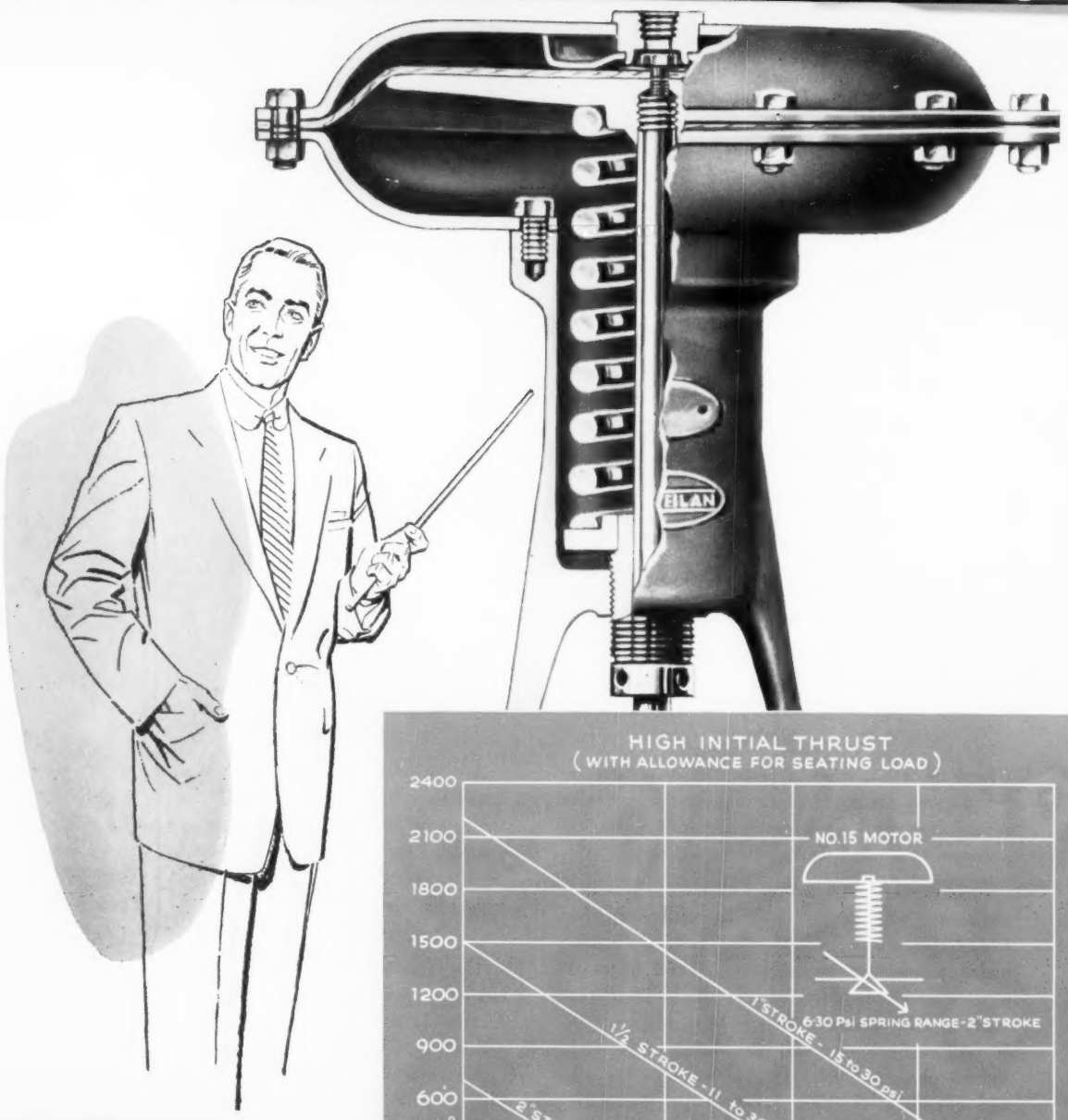
In launching this program it was our hope that other groups—manufacturers, utility companies, industry associations, publications—would develop programs with the same basic objective.

As the article on pages 79-81 indicates, these hopes have been amply realized. Several manufacturers have developed extensive programs for demonstrating the values of ample, expandable in-plant electrical systems and for showing management men, engineers, and architects how to secure those *power to grow* values in their own plants.

The American Institute of Electrical Engineers has study groups working on this problem. Edison Electric Institute and many member utility companies have demonstrated interest. And the Hugh C MacLean electrical business magazines have begun a paid advertising program to impress Canadian industry with the importance of adequate in-plant electrical systems.

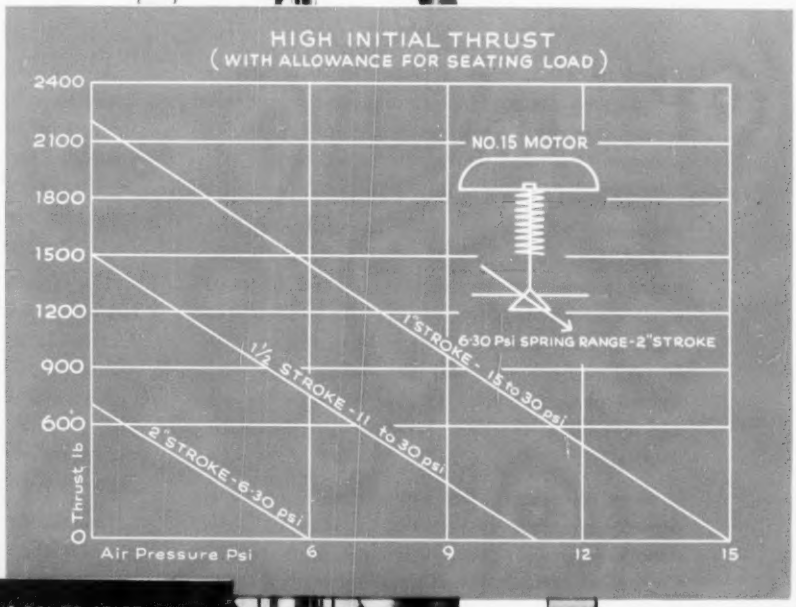
If confirmation were needed, here it is: All elements of the electrical industry agree that the need for ample and economically expandable electrical systems is a matter of paramount concern in today's manufacturing plants, service establishments and commercial buildings.

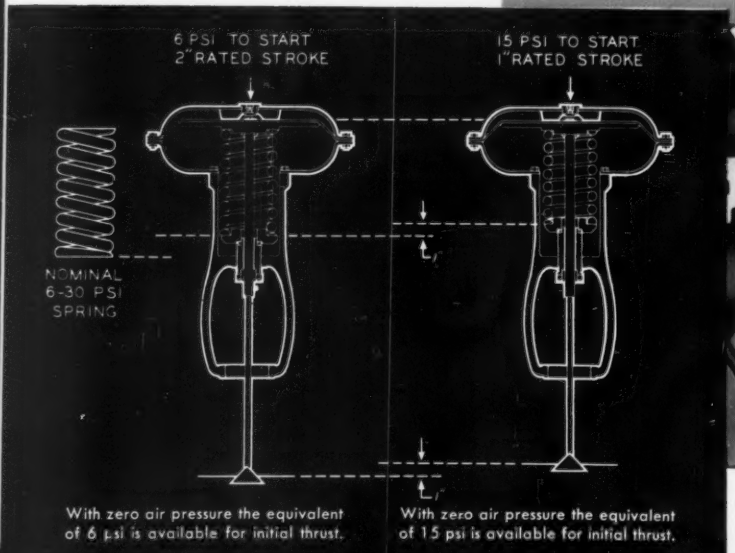
In the favorable climate created by this concerted approach to the problem, we count on power-service engineers everywhere to work with their managements to give America the *power to grow* that is so essential if we are to meet the challenge of the dynamic years ahead.

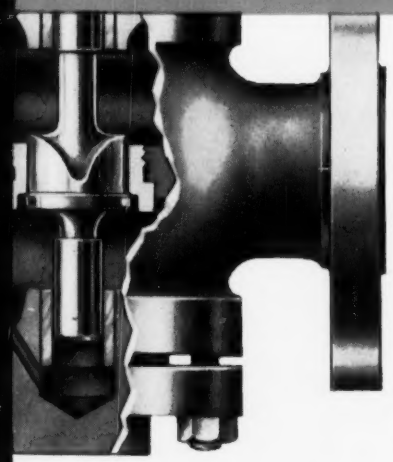


HIGH INITIAL THRUST:

Example — No. 15 Motor with 2" Rated Stroke and 6-30 psi Spring used on Valves with 2" and 1" Strokes.




6 PSI TO START
2"RATED STROKE
15 PSI TO START
1"RATED STROKE
NOMINAL
6-30 PSI
SPRING
With zero air pressure the equivalent of 6 psi is available for initial thrust.
With zero air pressure the equivalent of 15 psi is available for initial thrust.



In Single Seated Control Valves

Get AMPLE POWER plus SIMPLICITY, ECONOMY, SAFETY

with Masoneilan Spring-diaphragm Motors

You get the best combination of safety (action on air failure) with maximum potential thrust, plus inherent simplicity and reliability in Masoneilan Spring-diaphragm Motors for single seated control valves.

Many single seated valves are specified to close on air failure. Hence the initial spring compression must provide the force for closing, since the valve would normally be installed with flow tending to open. Thus, to overcome unusual off-balance forces, a high *initial* thrust must be developed.

On air-to-close valves, the motor should develop a high net thrust at the *end* of the stroke. Thus, to overcome unusual off-balance forces a high *final* thrust is essential.

The design of Masoneilan motors enables you to obtain high *initial* thrust or high *final* thrust or, in the case of three-way valves, *both* high initial and final thrust, using, in most cases, standard springs.

Here's how —

HIGH INITIAL THRUST: Usually an oversize motor is used with a standard spring, but with the difference in stroke used to gain more initial compression and consequent additional spring force.

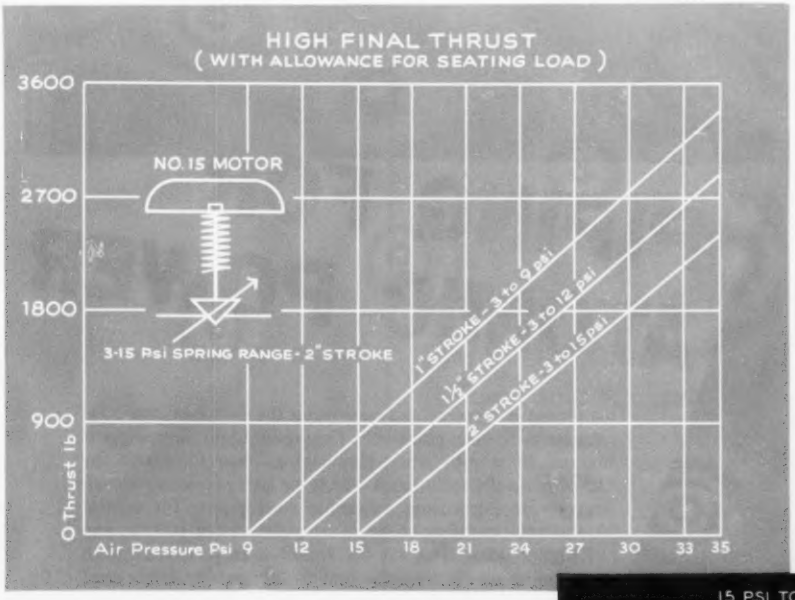
HIGH FINAL THRUST: The normal size motor often is used by simply increasing the air supply pressure to 30 or 35 psi. If necessary an oversize motor can be used to obtain even greater final net thrust.

HIGH INITIAL AND FINAL THRUST: Using an oversize motor permits adjusting the spring setting to obtain high initial thrust and makes an excess of supply pressure available for high final thrust.

Example — No. 18 Motor with 3½" Rated Stroke and 6-30 psi Spring used on Valve with 2" Stroke.

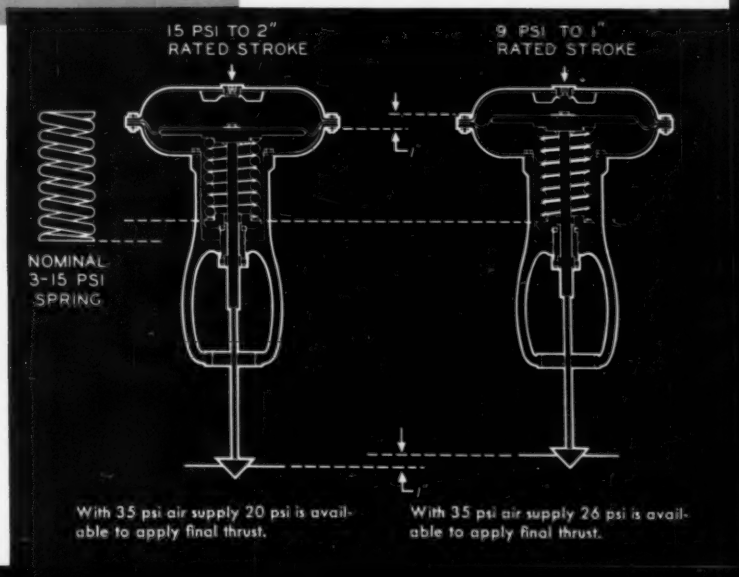
The spring can be set for 8-22 psi nominal range, giving an initial diaphragm load of 8 psi and (with 30 psi supply) 8 psi is also available for final thrust.

Tabulated data are available for facilitating correct control valve selection. Ask our nearest office for Data Sheet 10-11 — or write Mason-Neilan, Division of Worthington Corp., 33 Nahatan St., Norwood, Massachusetts.


HIGH FINAL THRUST
(WITH ALLOWANCE FOR SEATING LOAD)
3600
2700
1800
900
O Thrust lb
NO. 15 MOTOR
3-15 Psi SPRING RANGE - 2" STROKE
1" STROKE - 3 to 9 psi
1½" STROKE - 3 to 12 psi
2" STROKE - 3 to 15 psi
Air Pressure Psi 9 12 15 18 21 24 27 30 33 35

HIGH FINAL THRUST:

Example — No. 15 Motor with 2" Rated Stroke and 3-15 psi Spring used on Valves with 2" and 1" Strokes.


15 PSI TO 2"
RATED STROKE
9 PSI TO 1"
RATED STROKE
NOMINAL
3-15 PSI
SPRING
With 35 psi air supply 20 psi is available to apply final thrust.
With 35 psi air supply 26 psi is available to apply final thrust.

MASON-NEILAN

Division of Worthington Corporation

33 Nahatan Street, Norwood, Massachusetts

MASONEILAN

Sales Offices or Distributors in the Following Cities: New York • Syracuse Chicago • St. Louis • Tulsa • Philadelphia • Houston • Pittsburgh Atlanta • Cleveland • Cincinnati • Kansas City • Phoenix • Detroit San Francisco • Louisville • Salt Lake City • El Paso • Albuquerque Charlotte • Los Angeles • Corpus Christi • Denver • Appleton Birmingham • New Orleans • Seattle
Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

of 6 μsi is available for initial thrust.

of 15 psi is available for initial thrust.

ALL IN A DAY'S WORK AT *Pittsburgh Piping*

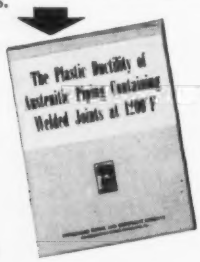
THE FIRST PIPING FOR ATOMIC POWER

Fabricated section in foreground is austenitic steel piping—the first fabricated for the world's first big atomic-power central station. Other components of this system are shown at the right.

This piping is a record maker—being the first ever made for a big atomic-power plant—the Duquesne Light Shippingport station. This job, while challenging, was facilitated by employing the techniques which we had previously developed for fabricating austenitic steel piping for central stations operating at steam temperatures of 1050°F. and higher, as well as for the *Nautilus*. In fact, Pittsburgh Piping was among the first to fabricate stainless steel piping—for the process industries, in 1927. And, we pioneered the use of stainless steel piping materials in the power field. We have the experience and the facilities—use them on your high temperature, high pressure piping jobs.

FREE TECHNICAL BULLETIN ON PIPING MATERIALS

This bulletin reports an intensive investigation into the problem of main steam piping materials and gives data on the stress rupture characteristics of Types 316 and 347 stainless steel piping adjacent to welded joints.



Promoting Progress ***IN POWER AND PROCESS PIPING***

Pittsburgh Piping **AND EQUIPMENT COMPANY**
158 49th Street—Pittsburgh, Pa.

Canada: **CANADIAN PITTSBURGH PIPING, LTD.,** 68 YONGE ST., TORONTO, ONTARIO

Atlanta ..... *Whitehead Building*
Chicago ..... *Peoples Gas Building*
Cleveland ..... *Public Square Building*
New Orleans ..... *P. O. Box 74*
New York ..... *Woolworth Building*

PP-33

Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge

The electrical industry, on several fronts, is doing something about the growing need for better planning of industrial electrical systems. Here is a rundown on what co-operation you can expect, aimed toward better design of . . .

Electrical distribution

- AIEE Industrial Power Systems Committee sat down last month and gave its technical blessing to a program of Study Groups beamed to industry's engineers
- Joint efforts of the EEI's Industrial Electrification Council, electrical contractors, equipment makers and utilities may bear fruit this spring in the form of a nationwide series of 7-session courses aimed to answer the why's and how's of look-ahead power systems
- Equipment builders are expanding their efforts jointly with utilities in sponsoring local get-togethers with potential customers for plant distribution gear

One of the key steps in making the Edison Electric Institute's long smoldering plan in the industrial electrical system area a reality, may be taken this month at an EEI directors' meeting. If given the nod, an organized program will be launched to join with others in focusing attention on the pressing need for look-ahead system design, and doing something about it.

Heart of the EEI's Industrial Electrification Council program is a 7-week training period pegged at responsible industrial plant people. Scope includes, (1) a review of engineering fundamentals as they concern industrial power distribution (2) practical techniques for evaluating existing systems (3)

GENERAL ELECTRIC kicked off their *More Power to America* program in 1945. The MPA Industrial Productivity Forum, geared to plant electrical distribution, gives industry's engineers the latest on new methods and equipment. This program will continue.

Don't miss two of the more recent films available under the MPA banner: *Goodbye Steve* dramatizes the critical need in industrial systems while commercial building film is titled *Tenant in 1010 Main.*

WESTINGHOUSE is right now putting on a road show, with the first meeting held last month in St. Louis. Formal kick-off for *Power-Up* came in November of '57 before the National Electrical Manufacturers Assn. Common thread running through the '58 *Power-Up* campaign is basically the pressing need for better electrical planning in industrial plants.

Program includes a do-it-yourself power checkup plan to study an industrial plant's electrical health.

"Of 550 plants checked, 85% had main circuit breakers

new methods and equipment available (4) benefits that come about through upgrading present systems. The package, to be put across with aid of local utilities, will probably include soundslide films, movies, texts—all selected for the small- and medium-size industrial.

Background provided by the course, according to committee chairman R R Johnson of Duquesne Light Co, should aid in dovetailing the efforts of contractors, equipment manufacturers and local utilities. When this program becomes a reality it will be the second major effort of IEC; first being the metal-sheath heater course which has been used by almost 40 major utilities with some 10,000 industrials participating.

AIEE study groups were launched during 1957, shortly after publication of the "Red Book" of industrial power distribution by the American Institute of Electrical Engineers. To date, several highly successful study sessions have been held throughout the country. Sponsored by local AIEE sections, the aim is simply to spread basic information on the right approach to modern power distribution design. You can expect similar study groups to crop up throughout the U. S. and Canada within a short time.

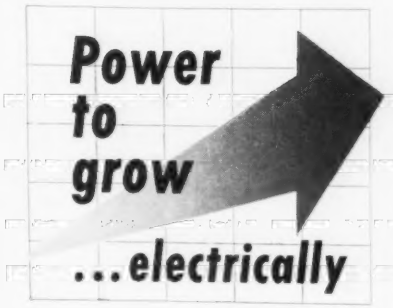
Typical study group is one launched February 18 in Cincinnati. Packed into a 10-session program are the important highlights; right from how to sell a system to management, through system design, to rules and regulations. In Hamilton, Ontario, a 5-session AIEE Study Group got under way on February 11.

What does all this mean to you? Frankly, you and your men are the targets for these programs. So you can expect during 1958 to be tapped to attend in person, or send one of your men, to one or more of these new informative sessions when they hit your city. It would be wise for you to accept.

Electrical manufacturers have been offering educational opportunities in power distribution and allied areas for many years. Typical is the *More Power to America* program kicked off by General Electric in 1945. The GE Industrial Productivity Forum points up the MPA approach. Co-sponsored by individual electric utility companies and GE, these forums bring together industrial customers and give them a rundown on latest developments in new products and methods. GE plans continuing these at the rate of 15 or 20 yearly. The 100th such meeting, co-sponsored with Public Service G & E of N.J., was held over a year ago in Newark, N. J.

The GE film *Goodbye Steve,* under the MPA banner, dramatizes the critical need for better planning of industrial power systems. Commercial building film counterpart is available under the title *Tenant in 1010 Main.*

Latest program offered by an electrical manufacturer is the Westinghouse *Power-Up* campaign launched last November by A C Monteith speaking before the National Electrical Manufacturers Assn. Westinghouseman Monteith pointed to a re-recent survey of 550 of the country's more important plants; plants large enough to have a complete engineering staff devoting full time to electrical matters. The survey showed every one of the 550 plants had inadequate main transformer capacity to handle loads coming in the next 10 years. Further, 52% had low incoming voltage, 85% had main circuit breakers too small for the interrupting duty, 94% had no automatic load ratio control, 89% boasted no main substation bus protection. Another Monteith point: "What good are all those



EDISON ELECTRIC INSTITUTE, through their Industrial Electrification Council, is working up a nationwide series of 7-session courses working closely with electrical contractors, equipment makers, utilities.

Although a formal name is not yet selected for this program, the aim is basically to spread technical know-how on industrial power distribution amongst key men in small- and medium-size plants. Campaign may get under way by midyear of 1958.

POWER TO GROW . . . *electrically* saw the light of day in the pages of POWER, Sept 1956. Since then the PTG editorial program has quite consistently placed in hands of readers technical data needed to tackle the job of better electrical planning.

The now widely referred to PTG index has become a plant designer's yardstick when asked for a tangible measurement of a plant's electrical-expansibility. And an index of 2 or 3 is not uncommon.

too small to safely handle tomorrow's growing needs"

dreams of electromation and increased output per worker if the very energy that is going to make all this possible can't even get in the front door."

Common thread running through all segments of the 1958 *Power-Up* campaign is basically the need for better electrical planning in industrial distribution. To back up their beliefs, Westinghouse is putting on a road show: first stop was St. Louis last month. One facet of the *Power-Up* package is a do-it-yourself power checkup plan to analyze a plant's electrical health. This includes a manual, calculator, reference chart and necessary forms for power analysis.

With business off in many industrial areas, you might logically question all this activity of planning for future growth at this time. Sure, if the future looked dark there would be some basis for concern. Actually, the business climate looks bright with an upturn expected before the year's end. Why? Answer lies in business getting a lift from an inventory turnaround, defense spending and from current efforts by the government to ease credit. These factors all point up the likelihood of rising consumer income, a safe bet for 1958.

Present inventory cutting can't go on forever, or even for many more months at the present rate. According to McGraw-Hill's Department of Economics there will have to be some upturn merely to produce what is being consumed. New orders by the Department of Defense for construction, missiles and allied equipment (plus research and development programs) will create growing demands in a wide business area. The mere knowledge that defense orders are on the upgrade should be an important factor in inducing business to replace, or at least maintain, inventories.

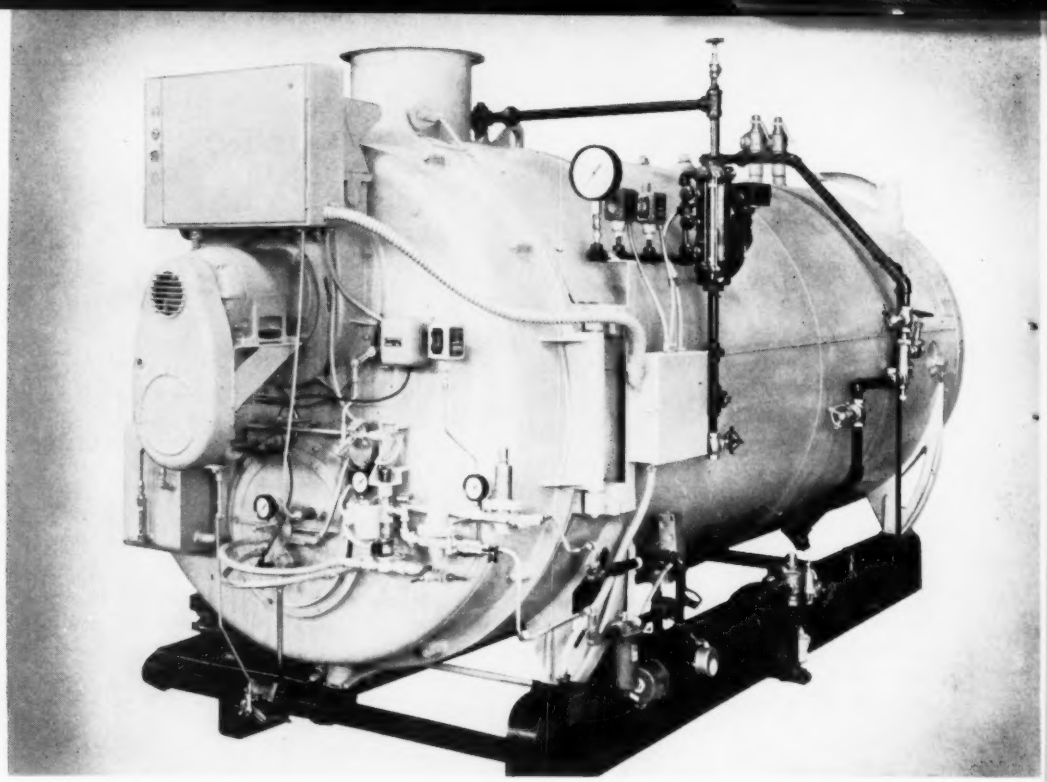
Personal income is the fuel driving the engine of consumer spending. So another reason behind the expected business upturn in 1958 is the assurance of a rising curve for income. There are few completely "sure" things in economics, but an uptrend in personal income does seem relatively well assured for this year. The combination of wage increases for the majority of employees still working, plus compensation payments to those now unemployed, should add up to an overall rise in personal income for '58. It still remains true that "as goes capital expenditures, so goes prosperity." And the economy will not return to anything approaching boom conditions until there is a higher volume of orders for new plants and equipment. Now let's go back to power distribution.

Power to Grow . . . *electrically* will continue as a significant editorial program in the pages of POWER. Formally introduced in September 1956, PTG has brought to power-service men in industry—and to their managements—the urgent awareness of the need for power to grow. And put in their hands the technical ideas needed to be sure they can grow.

What is really meant by power to grow? As mentioned, p 75, it became quite obvious some years back that there was a marked lack in forward planning of in-plant electrical distribution facilities. To spotlight the problem, POWER editors conceived this major editorial campaign to show how American industry must better plan to insure there will be power to grow.

Today, close to two years since the first PTG announcement in June of '56, we see widening acceptance of the theme across industry.

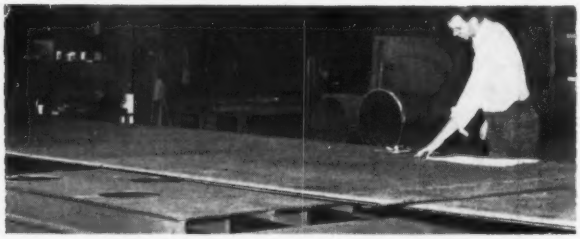
This program began with a 1-yr limit in mind: from where we stand now we don't see the end in sight.



Quality engineered—constructed under rigid control—is . . .

Today's packaged firetube boiler

By R H PIPKORN and E J RISSEEUW, Cleaver-Brooks Co

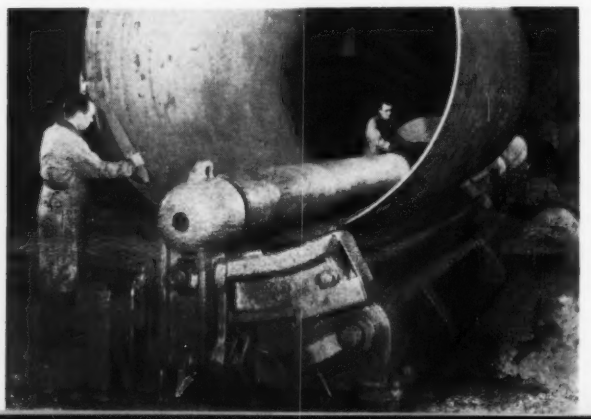


QUALITY CONTROL begins with foolproof inspections of all material

The quality of any product begins with design and continues with the raw material through manufacturing and final testing operations. To measure quality, it's first necessary to have some basis.

For packaged boilers, the ASME Codes provide minimum design and fabrication requirements for the pressure vessel. Mill test reports, bearing a number which is also stamped into plate, certify to material's quality. The number identifies the material even after it becomes part of a boiler.

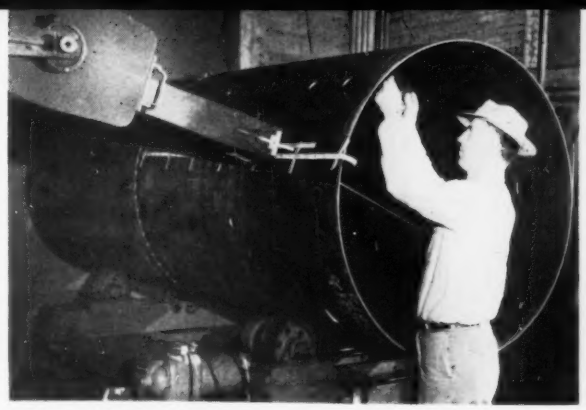
SHELL FORMING involves meeting Code tolerance plus insuring fit-up



Proper plate layout assures accurate cutting, well-fitted shells and tube sheets when parts are joined. Carefully controlled shell rolling, using templates to check roundness, is necessary not only to get good tube-sheet fit-up but to stay within ASME Code's permissible out-of-round tolerance.

When shell plate's edges are accurately aligned, they're fusion welded from inside and outside. This is also true of girth seams of boilers constructed with two or more courses of shell plates.

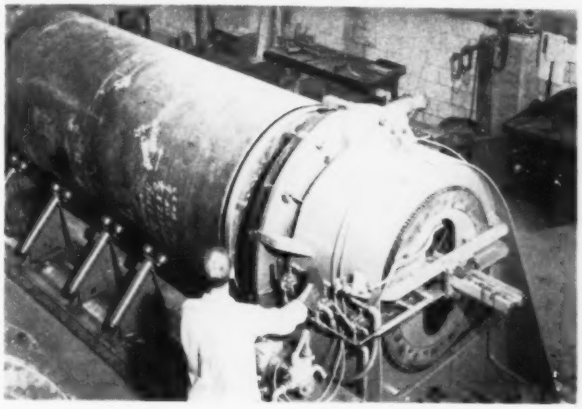
X-ray techniques prove welded seams of all shells built under ASME *Power Boiler Code*. Fine control of welding current, speed, flux composition and other factors is necessary to produce sound welds. Carefully examined X-ray films of each marked section on these seams reveal any imperfections. Any repair involving chipping or gouging of a defective weld requires re-X-raying to prove soundness as required by the Code. After completion of all pressure-part welding, entire shell undergoes a Code-prescribed stress-relief operation.



NONDESTRUCTIVE TESTING via X-ray probes welds for hidden flaws

Accurate fit is imperative to get top-quality construction on the tube-sheet-to-shell joint. To accomplish this fit in today's packaged firetube boiler, specially designed machines insert the tube sheets into the shells with a press-fit ready for the welding operation.

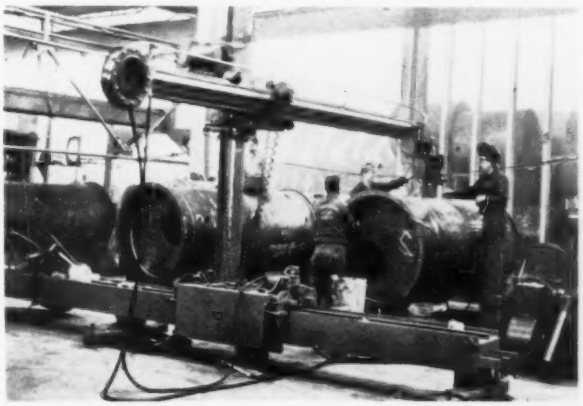
In thinking of the tube sheet as a positioning medium and receptacle for boiler's furnace and tubes, it must be remembered that it also serves as the pressure vessel's end closures. Tube-sheet area remaining after deductions for furnace opening and tube holes must withstand, as a flat plate, a loading tending to distort (dish) the plate. Thus, tube-sheet design involves careful calculation of plate thickness and bracing, if necessary, as required by the ASME *Boiler Code*.



PRESS-FIT gives quality fit-up to joint between tube sheet and shell

Automatic welding machine used in today's modern boiler shop is one of the important tools that promote uniformly high quality. Machines and their human operators are tested jointly under rigidly controlled welding procedures in accordance with ASME Code requirements. Employing a submerged-arc process, machines take over the bulk of X-ray quality welding on the boilers.

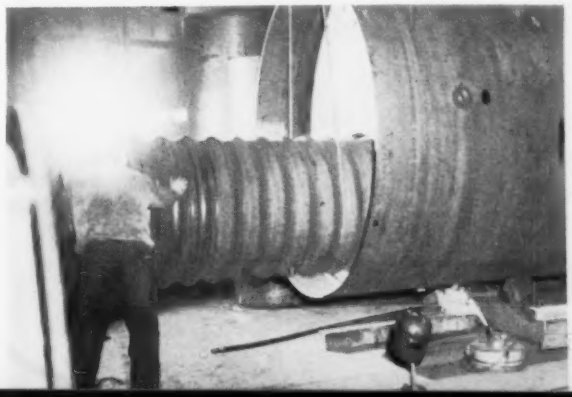
Though supervised by operators, the machines deposit weld metal under electrically controlled speed, current (heat) and voltage conditions and eliminate the potential day-to-day variations in manual welding. Used with power-driven positioning equipment to permit downhand (flat) welding, machines combine custom-quality weldments with economies of modern production-line techniques.

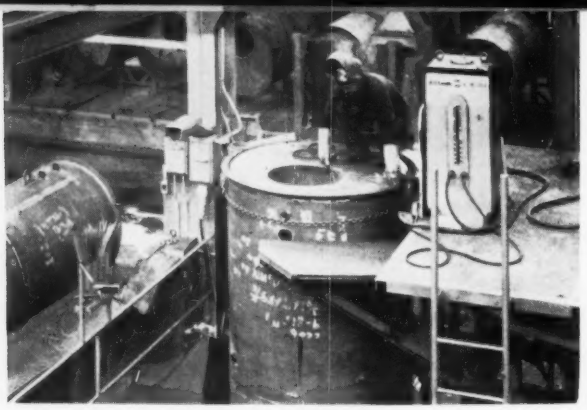


SUBMERGED-ARC welding promotes uniformly high-quality production

FURNACE DESIGN features heat-release rate plus strength factor

Furnaces are subject to *external* pressure (collapse), must be designed to conform with ASME Code's requirements for diameter-to-length ratios. Furnaces can be plain, ring-reinforced or corrugated. Corrugated, shown, is often used in larger diameter power boilers because its shape provides greater collapse resistance and more heat transfer surface per foot of length. Carefully inserted into holes prepared in the tube sheets, the furnace is fusion-welded into place.

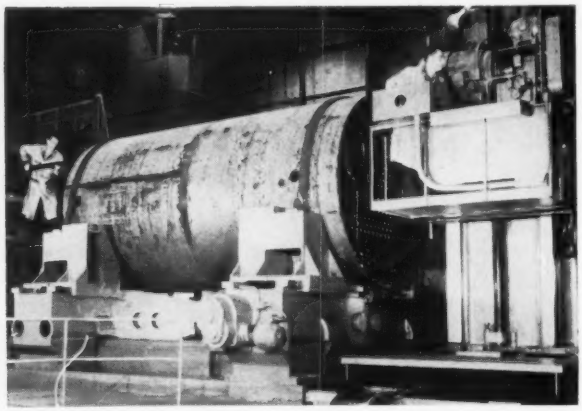




POSITIONING EQUIPMENT holds weldment in most convenient plane

Material-handling equipment plays an important part in getting consistently sound wells. For both machine and manual welding boiler shops use devices that permit practically all welding to be done in downhand (flat) position. This position is not only most convenient for the operation, but best for proper flow of the weld metal.

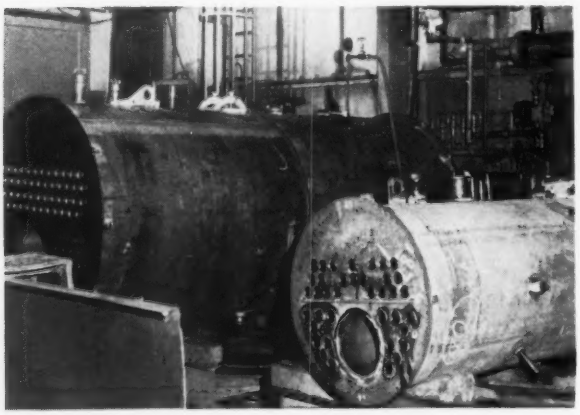
Following furnace insertion into tube sheets, previous photo, machine called an "up-ender" positions shell as shown. On completion of one end, shell is turned 180 deg to set up the other.



SPECIALIZED equipment for operations is typical of shop routine

Giant hydraulic-powered electronically controlled "boiler maker" is typical of specialized equipment used to assure fabrication accuracy.

Tube-hole size, concentricity and finish play an important part in getting good tube-to-sheet seal. The ASME Code is specific as to hole size for a given tube diameter to allow for proper rolling. But the Code doesn't cover out-of-round holes. This machine overcomes hole-distortion problems by accurately positioning holes (by photo-electric cell) after all welding is finished. After tube insertion, machine follows up by rolling and beading the tube ends. Some tubes, in higher-temperature areas, are rolled, welded and rerolled. Another machine similarly precision-controls size and location of shell openings.



HYDROSTATIC TEST of 1½ times design pressure proves vessel sound

After shell, furnace, tubes and attachment connections have been integrated, entire pressure-vessel unit gets a hydrostatic test of not less than 1½ times boiler's designed working pressure, as stipulated by ASME Code. Code further requires that completed boiler be tested "with water of a temperature not less than the temperature of the surrounding atmosphere and in no case less than 70 F." Also, "the pressure shall be under proper control so that in no case shall the required test pressure be exceeded by more than 6%."

The test's purpose is to determine that *all* welds are sound including those previously X-rayed, and to be certain that the furnace, tubes and other pressure parts have been properly installed.

ASME SYMBOL stamped on shell means conformance with *Boiler Code*

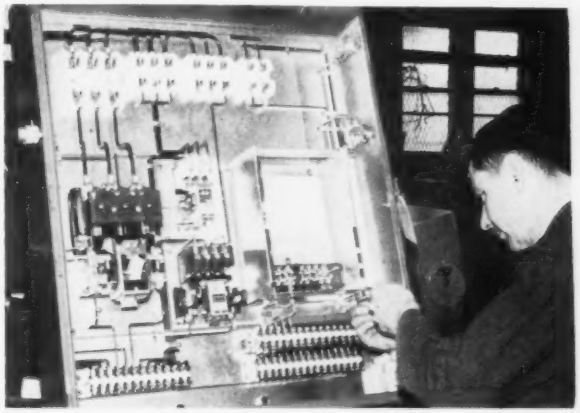
Hydrostatic test permits applicable ASME Standard symbol together with other mandatory data to be stamped permanently into boiler shell. Heat numbers, identifying the original material, are located nearby and these stampings certify that the boiler's material, design, fabrication, testing and inspection conform to requirements of the ASME *Boiler Code*. An accompanying form, available to user and inspection authorities, provides a complete record of the unit.

With stamping operation, pressure vessel itself becomes a completely assembled, inspected and approved unit. Now it moves along through process of attachment of non-pressure parts such as base frame, baffles, mounting flanges and vent stack. Though beyond *Boiler Code's* scope, this phase follows through with same degree of high-quality materials and workmanship. When the nonpressure components have been added, boiler shell is ready for final assembly. In this, furnace-refractory installation is one of the initial steps.

NONPRESSURE parts and workmanship hold high-quality level

Important operating and control components move onto the scene next. Pictured is a control panel as it is being built up as a sub-assembly. Installed on the boiler, this panel will be a self-contained unit housing boiler's "brain." Underwriters' Laboratories set minimum standards for controls and burner components. Reputable manufacturers regard these as truly minimum, and exceed them by a considerable degree of quality control throughout construction and testing.

With design accent on the highest safety and performance standards, the user gets the benefit of modern engineering research and development methods. Though ruggedly built, panels handle programming and safety controls with precision. With proper care, they give years of reliable duty.



CONTROL COMPONENTS and wiring meet UL's rigid specifications

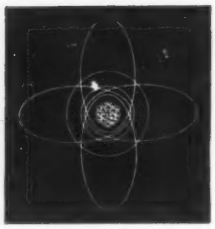
The burner equipment, built up as a sub-assembled head, is next step in the final-assembly program. Completely piped and wired into the control panel, the burner undergoes exhaustive testing in addition to firing performance tests necessary for Underwriters' Laboratories' approval.

The UL specifically distinguishes between Label A and Label B as follows: If burner of an oil-fired or gas-fired unit bears Label A, label applies only to the burner proper and does not cover heating equipment in which the burner is installed. Label B signifies that the heating unit and burner included therewith comply with the construction and test requirements of the laboratories. Such approval means much to the user.

BURNER EQUIPMENT conforms with UL's construction, test standards

FIRING TESTS with *user's* fuel prove overall boiler-burner efficiency

Boiler is now completed except for one important phase of the quality-control schedule—the operational test. This includes checking all operating and safety controls and adjustment of necessary components for the fuel the *user* will burn. For burner adjustment, fuel is accurately measured and stack gases analyzed for CO_2, CO and O_2. Inspection forms record final-test results and become reference basis in case some readjustment is necessary to meet local conditions.



Nuclear notes

By B G A SKROTZKI, Associate Editor

Canada plans 20-mw Nuclear Power Demonstration (NPD) project and 200-mw nuclear power plant to be built by its Atomic Energy of Canada Limited. Utilities and manufacturers will supply staff members for the design of these projects. AECL expects to develop the power plant in about four years—it will use natural uranium and a heavy-water moderator.

British place hopes in a ceramic uranium-dioxide (UO_2) fuel element canned with beryllium. They expect to raise fuel operating temperatures from 700 F to about 1100 F. This would raise power output of a pair of reactors from 300 to 800 mw.

How's fusion coming? Breaking newsfronts on British and American experiments in fusion and thermonuclear area show what's been done and lies ahead in scientific exploration. Both countries have reported achieving plasma temperatures up to about 11 million F for a few microseconds. British apparatus runs much larger in size than the reported American equipment at Los Alamos. Results must be judged by the number of neutrons released during reactions—tough part centers on knowing whether they were produced by true thermonuclear reactions or by ions accelerated by high voltages impressed on plasma.

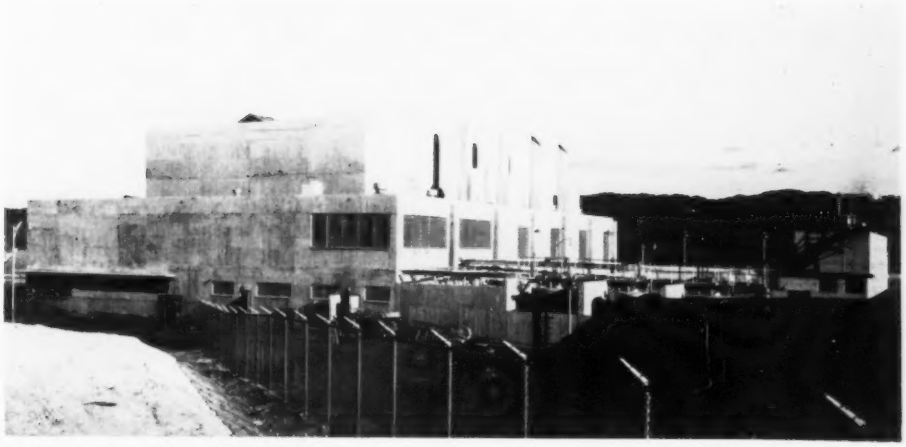
How far from the goal? Sun's surface temperature runs about 10 million F while core is estimated at 30 million F. Lower pressures for earthbound plasmas, and use of deuterium only, will force us to develop 700 million F if we want to get net power output from a thermonuclear reactor. Guesses on how long it will take to reach this level depend on who you talk to—anywhere from 10 to 50 years for a commercial reactor.

Mobile military reactors will come under study by Curtiss-Wright Corporation, General Electric Company and a team of General Motors Corporation and Nuclear Development Corporation of America when the AEC completes and approves contract negotiations with each of these organizations. These reactors must be compact and low weight, and develop up to 2-mw net output.

Maritime Gas-Cooled Reactor (MGCR) will be studied and built by General Dynamics Corporation for the AEC and Maritime Administration on completion of a satisfactory contract. Work will include development of high-temperature fuel elements, reactor controls, choosing coolant and moderator, selecting compatible gas-turbine plant. Plant is expected to run about seven years after contract date.

Government accepted APPR as a completed project on Jan 23rd. At the same time a new contract was given the builder, Alco Products Inc, to operate the 2-mw plant through June 30, 1959 for a fee of about $350,000. Plant will be run by a manager and crew that includes operating superintendent, assistant superintendent, four shift engineers, electrical-instrument engineer, research-development engineer, chemical engineer, health physicist, training coordinator and an instrument technician.

A $3-billion foreign market for nuclear goods over the next ten years is predicted by Vitro Corporation of America. They break this up into: $2 billion for power reactors, $1 billion for propulsion reactors, $30 million for research reactors, $10 million for radioisotopes and $75 million for engineering services.



FIRST NAVAL SHORE INSTALLATION to burn residual fuel in diesels is this 17,600-kw generating station

The Navy's Subic Bay installation, one of the world's largest residual-fuel-burning diesel power plants, couldn't be jeopardized by inability to get proper fuel. For protection, designers chose . . .

A diesel-fuel-cleaning system with a 2-stage centrifuge and wash solution

By D M LANDIS and E G BAHRET*

The U.S. Navy's multimillion-dollar power plant at Subic Bay in the Philippine Islands recently went on the line. Built under auspices of Bureau of Yards & Docks, it's one of the world's largest diesel-electric stations operating on residual oil.

Designers' major aim was to make the power plant equal to any emergency. As R R Patchen, chief engineer for Bureau of Yards & Docks' San Francisco office, put it: "This installation had to have much more security than a stateside plant — it doesn't have a utility to back it up."

It was obvious that the entire military installation at Subic Bay couldn't be jeopardized by a power-plant shutdown caused by equipment failure or—more likely—inability to get proper diesel fuel. Duplexing almost all engine auxiliaries so that failure of one wouldn't knock out the engine took care of the first potential hazard. Answer to the fuel problem lay in setting up a fuel-cleaning system that would enable plant to "burn anything." It would have to be capable of continuously purifying large quantities of NSFO (Navy Special Fuel Oil—comparable to No. 5 fuel oil) or, in an emergency, any residual available. Patchen pointed out that if supply lines from the U.S. were cut the plant could use crude from Java or Sumatra, or it could easily use fuel from naval or merchant ships.

Fuel-cleaning system might have been simplified if special equipment had been tailored for it, but designers elected to stay with proven, standard equipment—another bow to the need for reliability.

Previous use of DeLaval AC-VO nozzle-type units for purifying No. 6

*Mr Landis is vice-president, DeLaval Pacific Co, Millbrae, Calif., and Mr Bahret is engineer, Industrial Div, DeLaval Separator Co, Poughkeepsie, N. Y.

(bunker C) oil had been successful at a number of diesel-powered municipal generating plants. Some had been in operation for several years handling dirty and heavy residual fuels with viscosities running above 5000 ssu at 100 F. These centrifuges had been used together with a chemical-wash solution for purifying residual fuels in gas-turbine applications including first marine installation aboard the GTS *John Sergeant*.

Previous experience indicated that it was only necessary to remove water and sludge from residual fuel for diesels. However, considering Subic Bay's extreme importance, the chemical-wash solution process was added to the straight continuous centrifuging system—first time this purification system had ever been used in a diesel-fuel application.

The chemical-wash fuel-oil conditioning process (developed and patented by the General Electric Co) materially reduces oil's sodium and calcium content. The process intimately mixes a magnesium-sulfate solution with the heavy oil prior to centrifuging. (In gas turbines, sodium and calcium reduction resulted in far less ash deposit on blading, cut back on corrosion due to both sodium and vanadium-salts residue.)

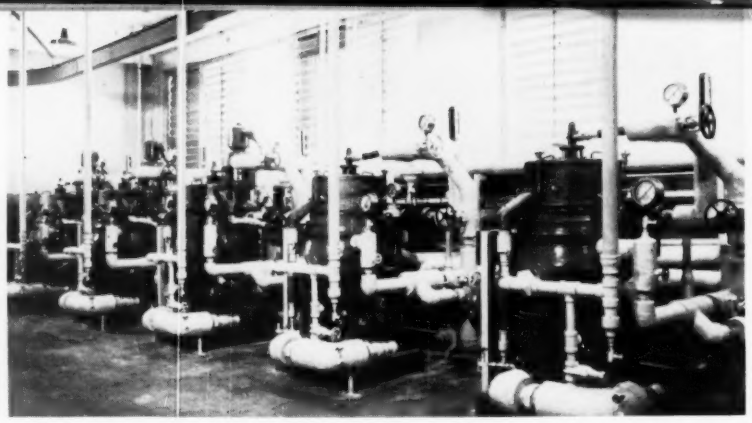
Solid-wall centrifuges couldn't be used because of possible high (up to 2%) bottom sludge and water (BS&W) content, so the choice was a continuous self-cleaning unit which discharges separated solids from nozzles at the bowl periphery. In addition to solids and water, some fuel oil passes through nozzles. This is recovered by recirculating sludge to the bottom of the bowl and through the flush assembly. Recovered oil is discharged with purified oil from machine's upper spout.

Sludge concentration builds up to 25 to 50% BS&W content as solids are continuously separated from incoming raw oil. Continuous or periodic sludge withdrawal from system maintains this concentration level.

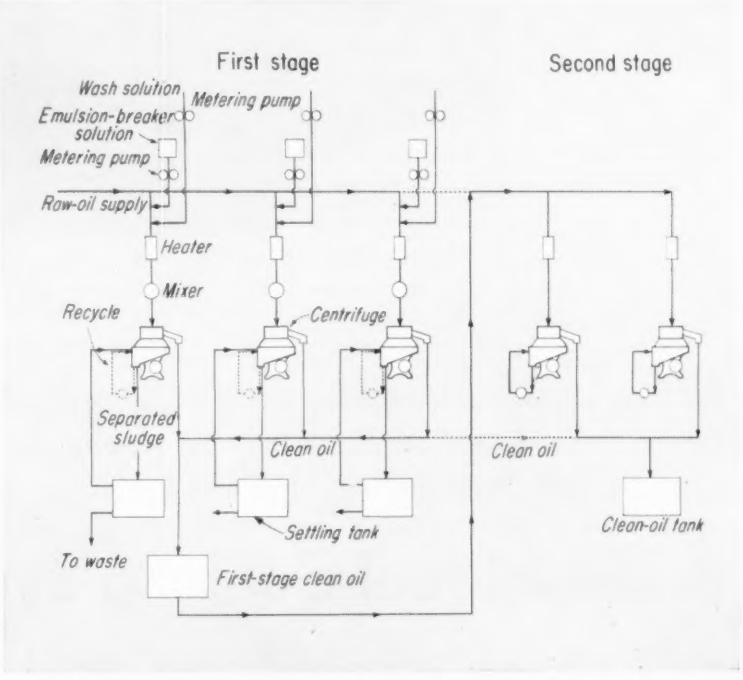
Schematic drawing, above, shows how three centrifuges operate as first-stage units when oil is washed with either fresh water or the chemical solution. Remaining two units operate as a second or polishing stage. First-stage operating rate is 600 gph of unpurified oil containing 20 to 30 gal of wash solution. Sludge and wash solution discharges to a 1600-gal settling tank which automatically decants sludge and water waste. Oil recovered from tank recirculates to the bottom of the centrifuge's bowl through the flush assembly. Clean oil moves from the unit's upper spout to first-stage clean-oil deaerating tank and then to second-stage centrifuges for final dehydration and cleaning.

Each first-stage centrifuge is complete with its own auxiliaries—heater, mixer, proportioning pumps, settling tank and transfer pump—and can be independently operated. It can handle up to 600 gph of residual fuel. Second-stage units can remove the last traces of finely-divided dirt and water at capacities of up to 900 gph. The entire 2-stage system will be used only if the plant has to resort to extremely poor-grade residual fuel.

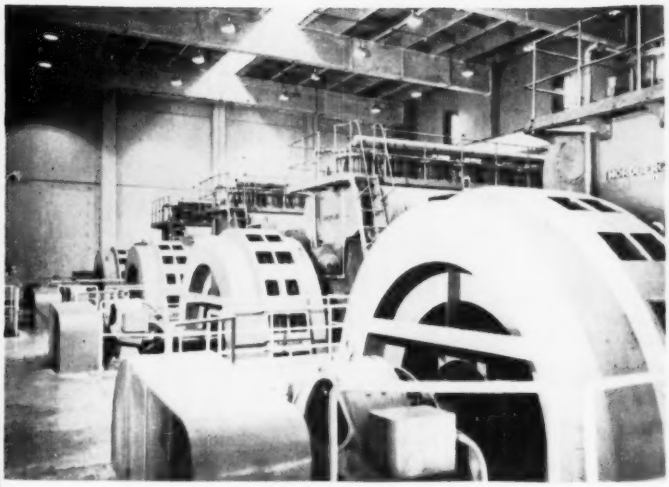
The NSFO and some available No. 6 oils are good enough for use after a single pass through a centrifuge without washing or chemical treatment. Nozzle discharge contains separated sludge and a large proportion of reclaimable oil which flows to individual surge tanks (integral with centrifuges) and recirculates to bottom of the revolving bowls. Latter



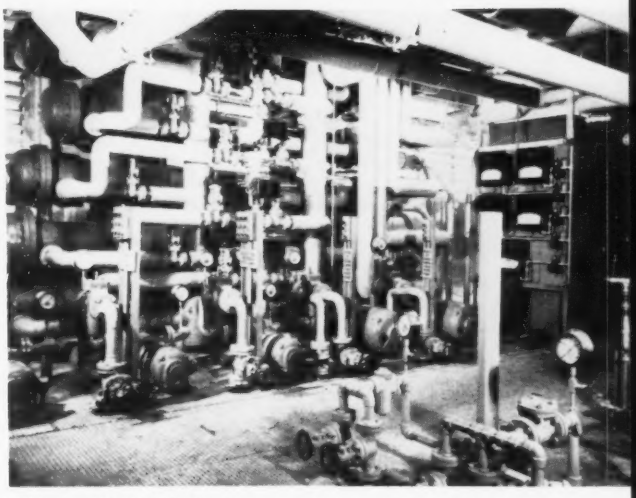
CENTRIFUGE ROOM is heart of the fuel-cleaning system. Drawn from 5000-bbl storage tanks, oil is purified here, then transferred to day tanks; through heaters to engines



TWO-STAGE arrangement of centrifuges, auxiliaries. Three units operate as first-stage when oil is washed with chemical solution. Two other units are second, polishing stage



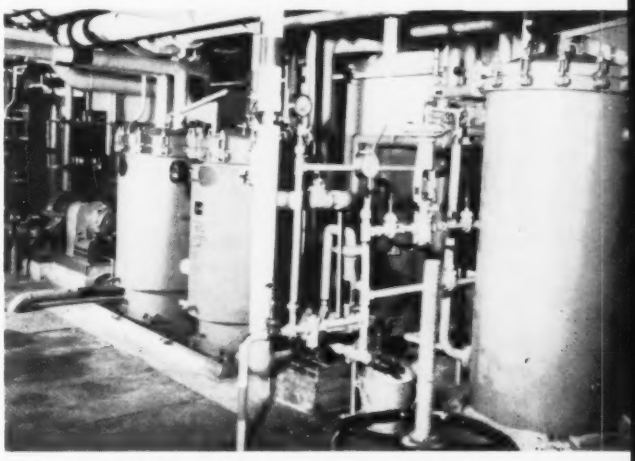
MAIN GENERATORS are each rated at 4.8 kw, 13.8 v. Diesel engines are 12-cylinder 2-cycle, burn NSFO or bunker-C fuel oil



PUMPS AND HEATERS are not only used in the fuel-cleaning process, but provide accurate viscosity control of fuel to engines

NSFO before and after centrifuging

	Before	After	% Reduction
Specific gravity, 60 F	.916	.916	
Viscosity, 100 F, ssu	950.	950.	
BS&W, % by vol	.45	.10	78
Water by distillation, % by wt	.20	.02	90
Solids by centrifuge, % by wt	.24	.08	67
Sediment, hot filtration, % by wt	.23	.05	80
Ash at 550 C, % by wt	.060	.040	33
Sodium uranyle acetate, % by wt	.0057	.0027	53
Vanadium, as V, % by wt	.0020	.0020	
Flash point, open cup, deg F	240.	240.	



FUEL AND LUBE-OIL FILTERS back up centrifuge, wash-solution cleaning system to assure maximum possible cleanliness for engines

feature gives optimum sludge concentration, minimizes disposal quantities of sludge and amount of burnable oil discarded with the sludge. Tabulation, above, shows before-and-after analyses of NSFO purification by this one-stage run.

To test all equipment and familiarize personnel with its operation, some bunker C was run through the complete 2-stage system, getting a sodium reduction of 70%. Reduction of other contaminating factors was also checked for comparison with single-stage centrifuging results.

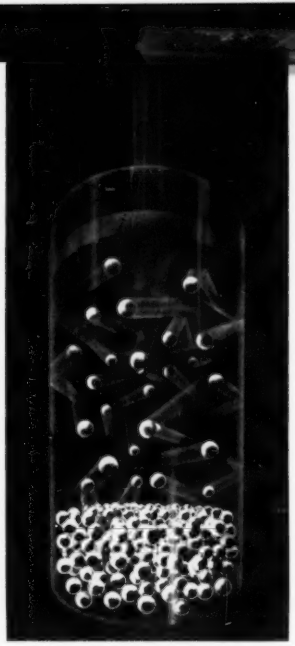
At times, Subic Bay plant may operate on No. 2 (regular) diesel fuel oil, so a solid-wall centrifuge with a top capacity of 1200 gph was provided for cleaning this fuel. Unit can also be used for batch purification of diesel lube oil at more than 600 gph. An additional small, high-speed centrifuge will rapidly determine BS&W content of both lube and fuel oils. Spinning two 10-cc samples at 12,000 rpm, unit determines solids content as low as 0.005%.

Centrifuges had a chance to demonstrate their ability to purify highly contaminated oil during initial NSFO processing. Pipelines between tank farm and plant were partially completed when the rains came. Slugs of mud and water accumulated in exposed piping. Result: the initial flow of fuel to centrifuges brought the mud and silt with it. This unprecedented contamination ran BS&W up to 20%. (Navy specs allow 0.5% max). But centrifuges never faltered—by adjusting solids withdrawal rate oil was purified to Navy specs and successfully burned in the engines.

The plant was designed by Bentley, Kellberg & Peugh; built by J H Pomeroy & Co, Hawaiian Dredging & Construction Co and Bechtel Corp.

THERMO REFRESHER NO. 17

By B G A SKROTZKI, Associate Editor



Burning fuels, our best source of heat energy, do most of the world's heavy work. Flaming explosive gases show their brawn when trapped behind reciprocating pistons. So let's learn . . .

How internal-combustion engines work

Let's study the heat and work relations of the well-known internal-combustion engines. Numerically and energywise, they are the most important type of prime mover in the U.S.A. today. The 75 million motor vehicles on our roads today have a total rated engine capacity of about 7.5-billion hp. They consume about 8×10^{15} Btu of motor fuel yearly. This represents about 20% of our total national fuel consumption for all purposes, such as power and heat.

Otto engine. Most of our autos use four-stroke-cycle spark-ignited internal-combustion engines modeled after the Otto engine first built about 1876. Fig. 1 shows the essential thermodynamic elements and the processes with which the engine works.

The basic principle depends on heating the working fluid trapped in a cylinder by a piston to raise the fluid pressure. The pressurized fluid then works on the piston to produce engine work output. The cylinder and piston ejects spent fluid, inhales a fresh charge and compresses it before heating it for the next cycle. Air mixed with vaporized gasoline forms the working fluid, and when ignited burns quickly and supplies the heat to raise the pressure.

In Fig. 1 we trace the actions step-by-step for an idealized engine. The P-V and T-S graphs show the change in state for the working fluid. The piston drives the constantly rotating flywheel, mounted on the output shaft, through the connecting rod as it oscillates back and forth in the cylinder.

In the first step, *state 1*, the inlet valve has just opened and the piston is at its head-end or top-dead-center (tdc) position. During the intake stroke *1-2* the fuel-air mixture flows into the cylinder at constant atmospheric pressure. Stored energy in the flywheel moves the piston from *1* to *2*, but the entering mixture does a small amount of work on the moving piston, $P_1(V_2 - V_1)$, equal to the area under the intake stroke *1-2* on the P-V graph. This stroke can't be shown on the T-S graph.

At *state 2* the piston stands in its crank end or bottom-dead-center (bdc) position and the working fluid fills the cylinder. The inlet valve closes and during process *2-3* stored energy in the flywheel moves the piston to reversibly compress the fuel-air mixture at constant-*S*. The area under *2-3* on the P-V graph measures the work of compression. On the T-S graph the process is a vertical line showing that no heat transfer is involved.

A spark ignites the fuel-air mixture at *state 3* and it burns quickly raising its pressure and temperature while the piston is at its tdc position. This constant-volume heating raises the mixture to *state 4*. Ideally, heating takes place instantaneously. Vertical line *3-4* on the P-V graph shows no work is involved. But the area under *3-4* on the T-S graph measures the amount of heat absorbed by the mixture at constant volume. Chemical fuel energy has been released by burning to develop thermal energy of the gas mixture during this process.

From *4* to *5* the hot combustion products expand reversibly and work on the piston at constant-*S*. The area under *4-5* on the P-V graph measures the work developed on the piston during expansion. Vertical line *4-5* on the T-S graph shows no heat transfer has taken place.

At *state 5* the combustion gas is still pressurized with the piston in its bdc position. The exhaust valve opens and some of the hot gas blows out to atmosphere till the cylinder pressure drops to atmospheric, *5* to *6*. This step can't be shown directly on the T-S graph.

From *6* to *1* stored energy in the flywheel moves the piston to push out the hot gas to atmosphere through the exhaust valve. The piston does work $P_1(V_1 - V_2)$ during exhaust. Area under *6-1* on the P-V graph measures exhaust-stroke work done on the gas.

At *state 1* the exhaust valve closes

and the inlet valve opens and we are ready to repeat the next cycle.

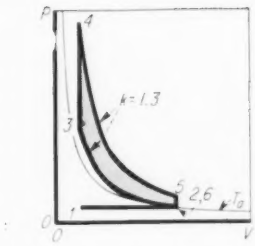
Otto cycle. We have looked at the idealized engine operations. For easy analysis we can simplify them to form the Otto cycle. The P-V graph shows that the works of the inlet and exhaust strokes, *1-2* and *6-1*, are equal but opposite. As far as contributing to the net work output of the engine they cancel exactly. (See Part 14, Dec 1957, pp 114-115 about the effect of piston speed on intake and exhaust pressure.)

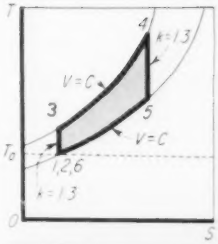
This leaves the cycle loop *2-3-4-5-2* in Fig. 1. We can imagine this as representing one pound of working fluid, say air, being compressed, heated and expanded as in the actual engine. But the process *5-2* can be visualized as a constant-volume cooling process rejecting unavailable energy and returning the air to its initial atmospheric condition.

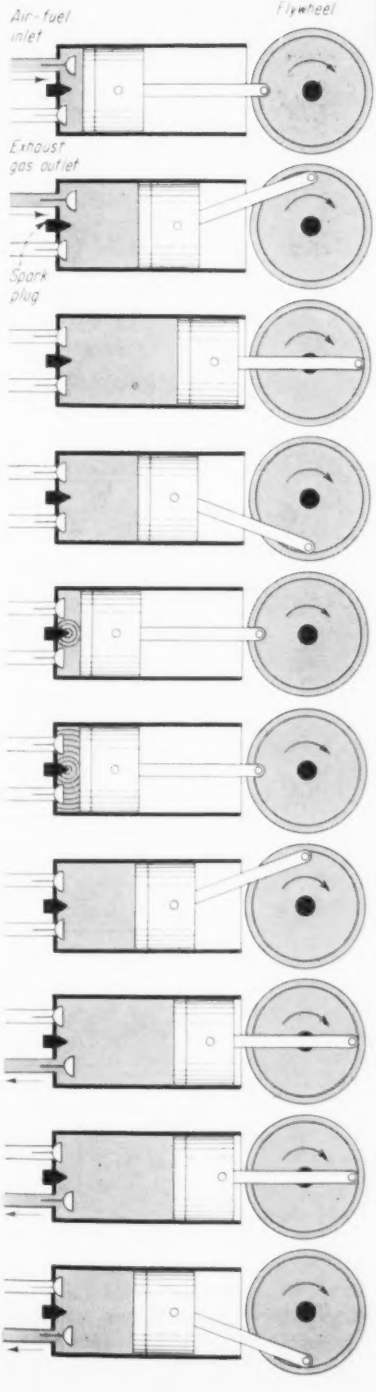
The area under *5-2* on the T-S graph then measures the amount of heat rejected during the constant-volume cooling. Because of the generally high temperature level of the cycle, we customarily call this the *hot-air standard* and use $k = 1.3$ for the reversible adiabatic processes with $c_p = 0.293$ Btu per lb and $c_v = 0.225$ Btu per lb. This makes the gas constant $R = J\,(c_p - c_v) = 52.9$.

With the Otto cycle we can study what happens to engine performance as we vary conditions. In Fig. 2*a* we have a cycle working between temperatures T_a and T_c. Expansion work of the hot air W_e is measured by the gray area under *3-4*. From this we must deduct the compression work W_c measured as the hatched area under *1-2*. This leaves the net area *1-2-3-4* as the net work output W of the cycle.

In Fig. 2*b* we have the total heat added at constant volume Q_A as the gray area under *2-3*. From this we deduct the heat rejected during cooling Q_R, hatched area under *4-1*. This

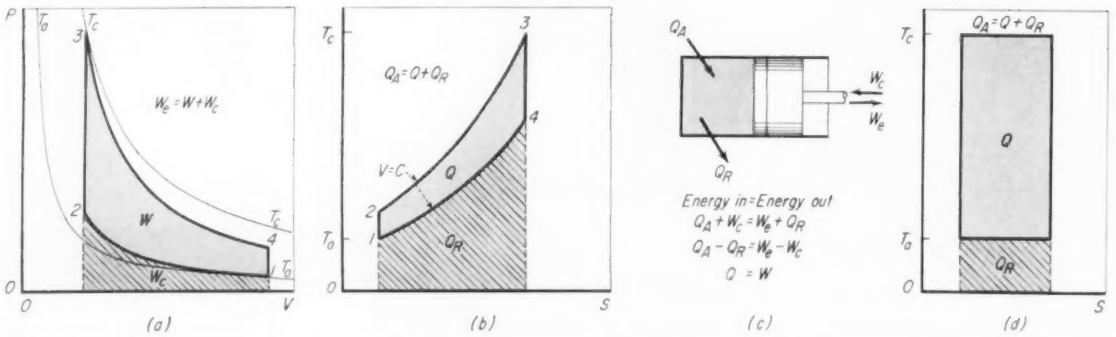






STATE	VALVE POSITION INLET	VALVE POSITION EXHAUST	ACTION	WORK	HEAT
1	Just opened	Just closed	—	—	—
1-2	Open	Closed	Air-fuel intake	Air to piston	None
2	Just closed	Closed	—	—	—
2-3	Closed	Closed	Compression	Piston to air	None
3	Closed	Closed	Ignition	—	—
3-4	Closed	Closed	Combustion	—	Input to gas
4	Closed	Closed	Max *T*, *P*	—	—
4-5	Closed	Closed	Expansion	Gas to piston	None
5	Closed	Just opened	—	—	—
5-6	Closed	Open	Exhaust blowdown	None	Gas to atmosphere
6	Closed	Open	*P* drop to atmosphere	None	Gas to atmosphere
6-1	Closed	Open	Exhaust	Piston to gas	Gas to atmosphere

1 Four-stroke spark-ignited internal-combustion engine working on the Otto cycle uses one stroke out of four to produce work output. Flywheel stores part of work output to compress air-fuel mixture before ignition, exhaust burned gases from cylinder and to draw in fresh charge of air-fuel mixture. Burning takes place instantaneously in the engine cylinder, *3-4*



2 Otto cycle absorbs heat at constant volume and variable temperature, *a* and *b*, making its thermal efficiency lower than that of the Carnot cycle *d*. Practicality of the Otto engine makes theoretical loss of thermal efficiency of only minor importance

leaves the net heat Q used by the cycle as the area *1-2-3-4*. Note that we regard the heat added to the cycle as being transmitted through the cylinder wall even though it is released in the cylinder in the actual engine.

Fig. 2*c* shows that $Q = W$ by using the first law analysis.

Cycle performance. The Carnot cycle taught us that maximum thermal efficiency can only be achieved when heat is added at the highest *constant* temperature and rejected at the lowest *constant* temperature. Fig. 2*b* shows that the Otto cycle violates both these conditions, the heats being transferred at variable temperatures.

Fig. 2*d* shows what happens when the heat Q_A of Fig. 2*b* is added to a Carnot cycle at the highest cycle temperature, T_c. Net $Q = W$ for the Carnot cycle is much larger than for the Otto. The much smaller Q_R for the Carnot highlights the better efficiency. Note the smaller entropy change of the Carnot cycle.

Temperature effect. Knowing the all important effect of temperature on thermal efficiency let us study how this applies to the Otto cycle. In Fig. 3*a* and *b* we have three cycles working between volumes V_1 and V_2. First let's analyze the thermal efficiency of cycle *1-2-3-8* working with a top combustion temperature of 1500 °R. Table 1 shows the relations for figuring heat transfers and net work in terms of the cycle temperatures. Equation (4) shows that the thermal efficiency can be figured from the temperatures.

But there's a unique relation between these temperatures and the specific volumes as shown by equations (5) and (6) based on the constant-*S* processes, see Part 8, May 1957, p 107. When we substitute these in equation (4) as shown, the temperatures disappear and we find that the thermal efficiency of the Otto cycle depends on the ratio of the specific volumes V_1/V_2 known as the compression ratio, V_r, and the ratio of specific heats, $k = c_p/c_v$.

Thus in Fig. 3*a* and *b* as we push up the final combustion temperature from T_3 to T_4 and T_5 we can see that the $W = Q$ areas increase while the W_c area remains constant. Q_A also increases to produce these higher temperatures and work outputs but the thermal efficiency remains constant as long as V_1/V_2 stays constant.

This means that if we regard each of the increment cycles *8-3-4-7*, and *7-4-5-6* as separate cycles, they all run at the same thermal efficiency because they have a common compression ratio $V_r = V_1/V_2$.

Work variation. Just how is the top temperature and work W re-

1—Otto-cycle thermal efficiency does not depend on temperature

1. $Q_a = E_3 - E_2 = c_v(T_3 - T_2)$ (See Fig. 3)
2. $Q_r = E_8 - E_1 = c_v(T_8 - T_1)$
3. $W = Q_a - Q_r = c_v(T_3 - T_2) - c_v(T_8 - T_1)$
4. $e = \dfrac{W}{Q_a} = \dfrac{c_v(T_3 - T_2) - c_v(T_8 - T_1)}{c_v(T_3 - T_2)} = 1 - \dfrac{T_8 - T_1}{T_3 - T_2}$

For the isentropic processes:

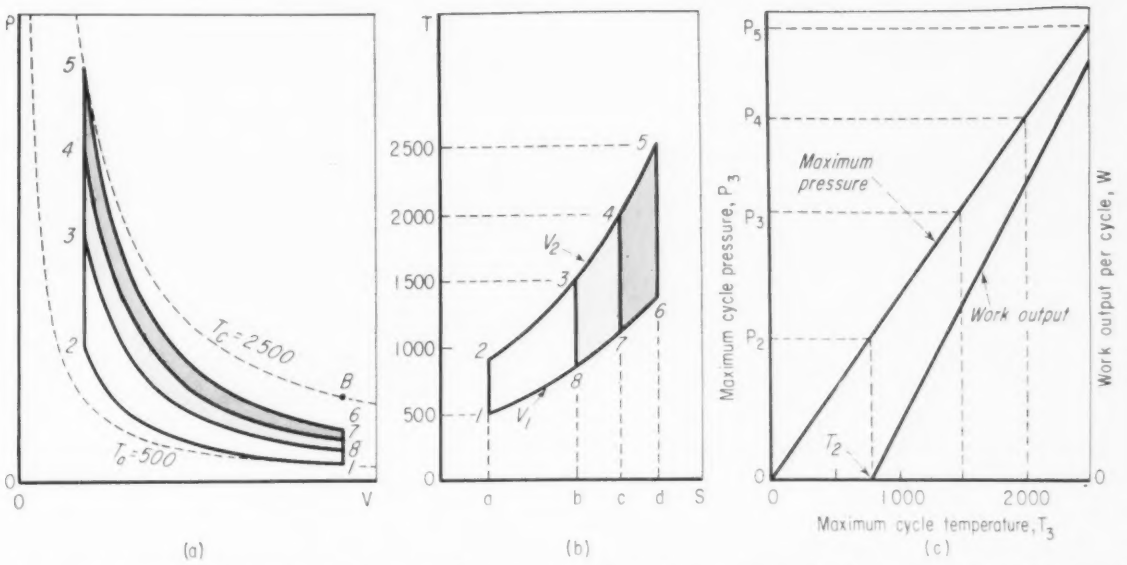
5. $T_8 = T_3\left(\dfrac{V_3}{V_8}\right)^{k-1} = T_3\left(\dfrac{V_2}{V_1}\right)^{k-1}$
6. $T_1 = T_2\left(\dfrac{V_2}{V_1}\right)^{k-1}$

Substituting (5) and (6) in (4):

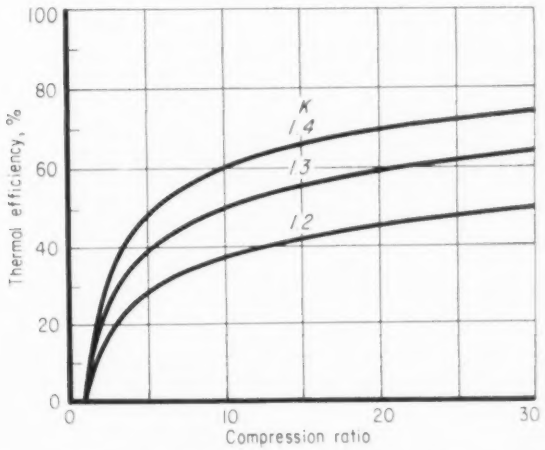
7. $e = 1 - \dfrac{T_3(V_2/V_1)^{k-1} - T_2(V_2/V_1)^{k-1}}{T_3 - T_2} = 1 - \left(\dfrac{V_2}{V_1}\right)^{k-1}$

Letting compression ratio be:

8. $V_r = V_1/V_2$
9. $e = 1 - \dfrac{1}{V_r^{k-1}}$



3 Thermal efficiency of Otto cycle depends only on the compression ratio, V_1/V_2. Varying the combustion temperature T_3 controls the net amount of work output per cycle—the thermal efficiency stays constant. Maximum pressure P_3 varies with T_3



4 Otto cycle thermal efficiency rises with increasing compression ratio and specific heat ratio; fastest rise at lower values

lated? From equation (3) in Table 1 we can write:

$$W = c_v(T_3 - T_2 - T_8 + T_1)$$

Substituting for T_8 from equation (5) we get:

$$W = c_v\left[T_3 - T_2 - T_3\left(\frac{V_2}{V_1}\right)^{k-1} + T_1\right]$$

$$W = c_v T_3\left[1 - \left(\frac{V_2}{V_1}\right)^{k-1}\right] + c_v(T_1 - T_2)$$

For a given engine with fixed compression ratio and T_1 the compression temperature T_2 would also be fixed. The only variables in the work equation are W and the combustion temperature T_3. So lumping together all the constants we get:

$$W = CT_3 - K$$

Fig. 3c shows the plot of this equation of W versus T_3. When combustion temperature T_3 rises above compression temperature T_2 the engine develops net work W in direct proportion to the difference $T_3 - T_2$.

An important factor in engine design is the maximum combustion pressure developed, P_3. Since combustion heating takes place at constant volume, maximum pressure P_3 varies directly with the absolute combustion temperature T_3.

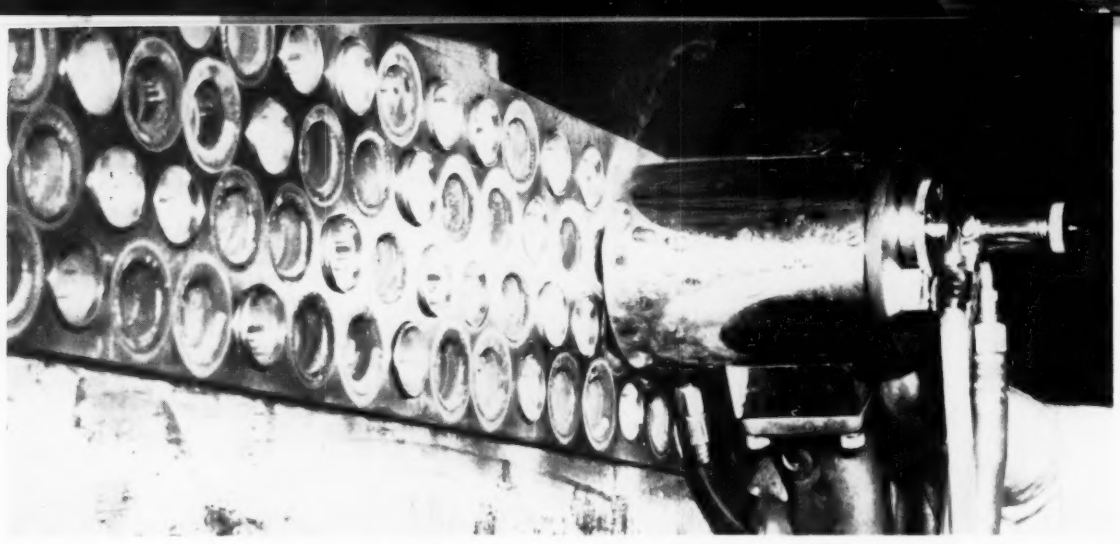
This tells us that we can vary our engine output simply by varying the amount of heat released in the cylinder and so vary the combustion temperature. To develop high output we must be sure that the cylinder is strong enough to withstand the peak pressure.

In an actual engine we control the heat input by varying the amount of gasoline vapor injected into the air. The mass of air stays essentially constant for all outputs. We'll discuss actual engine behavior in a later part. Keep in mind that we're talking about a simplified ideal cycle to sort out the different relations more easily.

Fig. 4 shows the variation in Otto-cycle thermal efficiency with both compression ratio and specific heat ratio k. Efficiency rises rapidly up to compression ratio of about 10, then it grows slowly.

Peak pressure and temperature have a simple relation to the compression ratio in the Otto cycle. Let's study the overall cycle *1-2-5-6* in Fig.

(*Continued on page* 202)



1 Control unit used with this semiautomatic welding gun gives prepurge of weld area with shielding gas, arc initiation, one complete rotation of the welding torch plus 20 degrees overlap and current decay to eliminate cracks whenever the arc is broken

Welding equipment can make a reliable tube to tube sheet joint. But what about mechanical strength, joint leak tightness, weld distortion and resistance to cyclic stress? Part 1 of a 3 part series outlines the test program set up to throw more light on these mechanical effects of . . .

Welding copper-base alloy tubes

By J F SEBALD and L H HAWTHORNE*

Ever since the first steam condenser, designers have wrestled with the problem of fastening heat-transfer tubes to tube sheets. The joint must (1) have high mechanical strength (2) be free of leakage (3) not produce excessive fluid-flow cavitation and (4) have good corrosion resistance. Many methods give satisfactory and economical solutions to this design problem on specific jobs. But none show as much promise as welding for meeting all these design needs.

Demand for optimum steam and condensate purity in plants using once-through boilers or nuclear energy as a heat source has greatly stimulated welding research. Result, welding equipment is now available that can produce a reliable tube-to-tube-sheet joint. But the designer or prospective user is still not assured that the process can be applied to surface condensers of every size.

There are many unanswered questions about (1) distortion from welding (2) relation between distortion, tube-sheet thickness and materials welded (3) resistance to repetitive stress and (4) potential resistance to corrosion.

Available information about mechanical strength, and leak tightness of joints also needs to be verified under simulated manufacturing conditions. Existing data was generally obtained on a laboratory basis.

Our test program was devised to answer some of these questions. The data presented will not only help resolve design details needed to produce a good weld joint, but will minimize the risk on large surface condensers and assure a satisfactory total structure.

Tube materials selected for study are those most commonly used in steam condensers. They include arsenical copper, admiralty and aluminus brass produced in accordance with ASME materials specification SB-111. Tube-sheet materials include naval brass, SB-171 and copper silicon, SB-96.

The complete test program is outlined on page 95 in chart form. Leak-tightness and pressure-strength tests are reported for all these materials in various combinations. Tube-sheet distortion tests, strength tests and cor-

* J F Sebald is Chief Engineer, Condenser and Heater Section, Worthington Corporation. L H Hawthorne is Manager, Welding Section, Research Department, Revere Copper and Brass Inc. Article is based on the authors' part in a panel on "Welding of nonferrous tubes to tube sheets," 1957 ASME annual meeting in New York

Here's a complete summary of the overall test program

Test program	Section I Parts A & B	Section II Parts A, B, C & D	Section III Parts A, B, C, D, E, F, G & H	Section IV Parts A & B
Purpose	Investigate leak tightness and joint strength under fluid pressure	Measure tube-sheet distortion from both manual and machine welding and the effect of consecutive and skip sequence tube welding. Find actual mechanical strength	Measure tube-sheet distortion from machine welding of tubes in preferred sequence with various material combinations and tube-sheet thicknesses. Test for actual mechanical strength	Measure tube-sheet distortion from welding tubes in tube sheets under simulated manufacturing conditions. Find stresses induced in tubes from both rolling and welding. Test resistance of welded only and welded and rolled joints to cyclic stress
Tube and tube-sheet materials	Tubes — 7/8-in. OD #18 BWG 14 admiralty, 18-in. long 14 aluminum brass, 17 31/32-in. long 14 arsenical copper, 18-in. long Tube sheets welded to steel shell Part A — 2 naval brass, 1 1/4-in. thick Part B — 2 copper silicon, 1 1/4-in. thick	Tubes — 7/8-in. OD #18 BWG 150 admiralty, 12-in. long Tube sheets — simply supported 1 copper silicon, 7/8-in. thick, 4 3/4 x 48 in.	Tubes — 7/8-in. OD #18 BWG Parts A, C, E & G 150 aluminum brass, 12-in. long Parts B, D, F & H 150 admiralty, 12-in. long Tube sheets — simply supported, 4 3/4 x 48-in. Parts A & B — copper silicon, 7/8-in. thick Parts C & D — 1 1/2-in. thick Parts E & F — naval brass, 7/8-in. thick Parts G & H — 1 1/2-in. thick	One heat-exchanger frame assembly with two tube sheets and center support sheet positioned to bow the tubes 5/8-in. in an 8-ft length Tubes — 7/8-in. OD #18 BWG 142 admiralty, 8-ft long Tube sheets, fixed end support, 4 3/4 x 54-in. 2 — copper silicon, 7/8-in. thick Support sheet — 2 ends fixed, carbon steel, 3/4-in. thick
Welding	Machine welded — unspecified sequence	Part A — manual, consecutive sequence Part B — machine, consecutive sequence Part C — manual, skip sequence Part D — machine, skip sequence	Machine welding, preferred method (skip sequence)	Part A Machine welded, skip sequence Part B Machine welded, consecutive sequence
Rolling	Automatic control (after welding & Halogen leak test)	Parts A & B — automatic control, after welding — consecutive sequence Parts C & D — same, but skip sequence	Automatic control after welding — preferred method (skip sequence)	Automatic control after welding Part A — preferred method (skip sequence) Part B — consecutive sequence
Tests	Halogen leak test @ 45 to 50 psig All leaks recorded and repaired prior to hydrostatic test to destruction	Tube-sheet distortion measurement after (1) machining (2) swaging (3) welding (4) peening and (5) rolling Mechanical strength measurements (1) Pulled through back of tube sheet, welded only (2) Pulled through back of tube sheet, welded and rolled (3) Pushed through front of tube sheet, welded and rolled Temperature measurements (1) Adjacent to weld immediately after welding (about 5 sec)		Tube-sheet distortion after (1) machining (2) swaging (3) welding (4) peening and (5) rolling Longitudinal stress in tubes after (1) welding (2) rolling Resistance to cyclic stress (1) Tubes welded only (2) Tubes welded and rolled

rosion investigations cover combinations of admiralty and aluminum-brass tubes with naval-brass and copper-silicon tube sheets. Also, Section IV of the test program will give data on resistance to cyclic stress conditions in simulated heat-exchanger construction for the admiralty tube and copper-silicon tube sheet designs.

Tube sheets, except for those in Section 1, are strips with a high enough length to width ratio to be considered beams. For comparison, the flexibility of the sheets or strips in Sections II and III, (simply supported structures lightly held at each end) is the same as that of an 8-ft-dia tube sheet of the same thickness built in at its circumference.

The flexibility of tube-sheet strips in Section IV is about the same as that of a 6-ft-dia tube sheet, 7/8-in. thick, built in at its circumference. Flexibility of the 7/8-in. tube-sheet

strips in Section II and III is more than three times that of the ⅞-in. tube-sheet strips in Section IV.

Tube-sheet preparation and joint design. The tube sheets are drilled and reamed to receive tubes, Fig. 5 and 6. Tube hole, Fig. 5, is for admiralty metal, aluminum brass and arsenical-copper tubes with copper-silicon tube sheets. It's also used for admiralty metal and arsenical-copper tubes with naval-brass tube sheets. Joint, Fig. 6, is used for aluminum-brass tubes and naval-brass tube sheets. These drawings show the geometry desirable for high welding quality, taking into account basic differences in the various materials.

Cleaning. Surfaces of the tube sheets are thoroughly cleaned by mechanical means. This gives optimum welding conditions and prevents defective welds from oxides within the joint. Tube sheets are degreased with steam and a nonresidue forming solvent to remove any volatile material. Tubes are not specially cleaned since they are usually received in good condition, and normal storage and handling facilities are good enough to prevent formation of any objectionable amount of oxides.

Swaging. Tubes are first inserted in the tube hole and held in proper position with respect to the tube sheet. The back-up bar is held against the opposite end of the tube. The swage, hand-hammer driven, expands the tube end, produces a conical shaped entrance in line contact with the common line of intersection of the two tapers in Fig. 5 and 6. This forms the entrance to the cylindrical hole in the tube sheet and completes the swaging operation.

Welding tubes to tube sheets. All welds used to produce tube to tube-sheet assemblies in this test series are fusion welds made by the gas-shielded tungsten arc process without using filler metal.

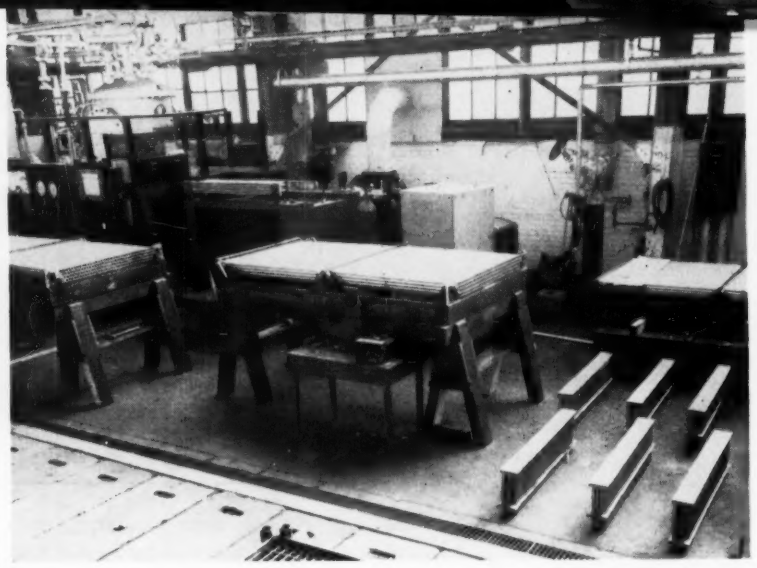
Manual welds, Section II, use standard gas-shielded tungsten arc equipment with a suitable dc power source.

Semiautomatic welding equipment consists of a specially designed gas-shielded tungsten arc torch on a rotating mandrel. The mandrel indexes on the tube to be welded, maintaining complete concentricity between the arc path and the periphery of the tube. Torch and supporting mandrel are carried within a housing equipped with bearings and a worm-gear drive. This complete assembly constitutes the so-called welding gun, Fig. 1.

The mandrel itself is rotated by a flexible cable drive from the control unit. Welding current, coolant for the torch and shielding gas are supplied from the control unit through flexible hoses. The current-carrying cable is enclosed in the coolant discharge hose, permitting use of lightweight cable with optimum mechanical flexibility.

Correct arc length is maintained by a microswitch on the gun housing. The welding cycle will not start unless this switch has proper contact with the tube sheet.

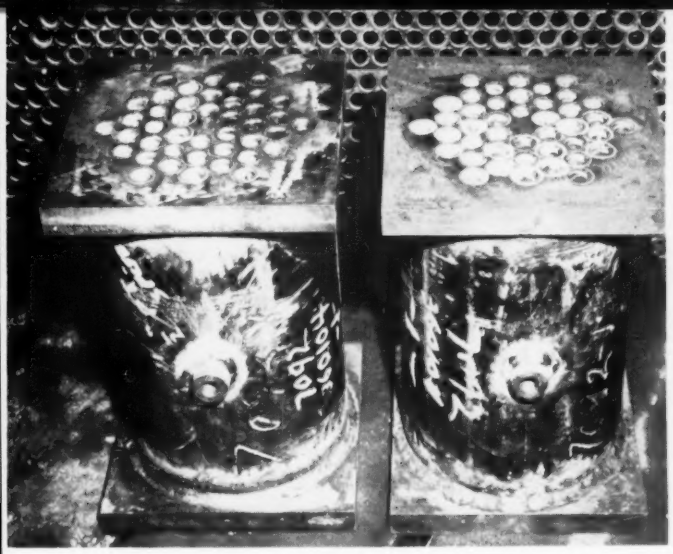
The welding-gun control unit gives (1) prepurge of the weld area with shielding gas (2) arc initiation (3) rotation of the welding torch through one complete revolution (plus 20 deg to give enough overlap at the start



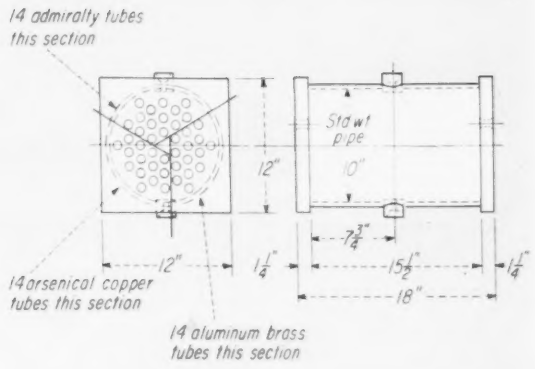
2 Here are some of the test assemblies and the general work area used for the tests. Three simulated heat exchangers are shown with strain-gage instrumentation attached

Welding data for the complete test program

Test	Materials		Tube-sheet thickness, inches	Welding	Gas flow cu ft/hr		Volts	Amps	Welding time, seconds	
	tube	tube sheet			A	He			arc	total
1A	As-Cu	Naval brass	1¼	Machine	20	0	12	240	15	18.5
1A	Admiralty	Naval brass	1¼	Machine	20	0	12	200	11	15
1A	Al-Br	Naval brass	1¼	Machine	5	15	12	135	11.5	15.5
1B	As-Cu	Cu-Si	1¼	Machine	20	0	12	200	8	11.5
1B	Admiralty	Cu-Si	1¼	Machine	20	0	12	180	8	11.5
1B	Al-Br	Cu-Si	1¼	Machine	5	15	12	150	16	20.5
2A	Admiralty	Cu-Si	⅞	Manual	10	5	12	105	11	11
2B	Admiralty	Cu-Si	⅞	Machine	20	0	12	180	8	11.5
2C	Admiralty	Cu-Si	⅞	Manual	10	5	12	105	12.5	12.5
2D	Admiralty	Cu-Si	⅞	Machine	15-20	0	12	180	8	11.5
3A	Al-Br	Cu-Si	⅞	Machine	5	15	12	160	12	16
3B	Admiralty	Cu-Si	⅞	Machine	15-20	0	12	180	8	11.5
3C	Al-Br	Cu-Si	1½	Machine	5	15	12	150	16	20.5
3D	Admiralty	Cu-Si	1½	Machine	20	0	12	180	8	11.5
3E	Al-Br	Naval brass	⅞	Machine	5	15	12	135	11.5	15.5
3F	Admiralty	Naval brass	⅞	Machine	20	0	12	200	11	15
3G	Al-Br	Naval brass	1½	Machine	5	15	12	140	11	15
3H	Admiralty	Naval brass	1½	Machine	10	15	12	185	11.5	15.5



3 Leak tightness and joint strength of these two pressure vessels with tubes welded to tube sheets is measured under section I



4 Tube sheets in each assembly are laid out to include 14 tubes each of admiralty metal, arsenical copper and aluminum brass

of the weld) and (4) current decay to eliminate craters or cracks when the arc is broken. Control is completely automatic and once adjusted the operator doesn't have to control these functions during the actual welding cycle.

Measurements and tests. Leak test for Sections IA and IB uses a tracer of freon-11 with air at 45 to 50 psig. Source of leakage is found by probing the two vessels in their entirety with a leak-detecting instrument.

Hydrostatic test for Sections IA and IB uses water as the test fluid. Pressure is gradually increased until mechanical failure or leakage occurs.

Tube-sheet distortion measurements are taken from dial micrometers referenced from a fixture indexed from specific points on the face of each tube sheet. About 30 measurements determine the face profile of each tube sheet after completion of each phase of tube installation procedure.

Temperature measurements are made in the heat-affected zone adjacent to the weld immediately after welding (3 to 5 sec) using thermocolor-temperature indication.

Weld-strength measurement is based on a statistically significant number of tube tests (about 30). Test conditions include (1) pulling through back of tube sheet; tubes welded only (2) pulling through back of tube sheets; tubes both welded and rolled (3) pushing through front of tube sheets; tubes both welded and rolled. Force needed to break each joint is measured by relating hydraulic cylinder pressure to load with a calibrated hydraulic press.

Longitudinal stress, (compression or tension) is measured in selected tubes from Section IVA and IVB. Four Baldwin Type A7 strain gages are used for each tube tested under conditions of both welding and welding and rolling. Because longitudinal stress is of primary interest the strain gages are located at the calculated point of inflection (zero bending moment).

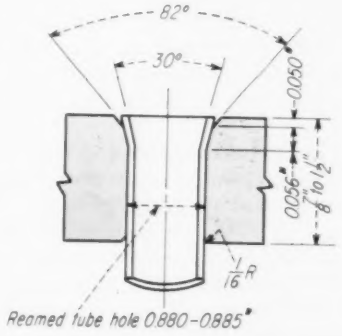
Resistance to cycle stress is tested in Section IV Parts A and B. Simulated heat exchangers are vibrated at frequencies corresponding to the natural frequency of tubes in both welded and welded and rolled conditions. Test is continued at a fixed vibration amplitude until a significant number of failures occur in both types of joints, or estimated endurance limit of the tube material is exceeded. Vibration frequency and time for failure is recorded.

During all tests, welding time, arc time, welding current and voltage are recorded. Records are also kept of the amount and mixture of inert gas (helium and argon) used during welding.

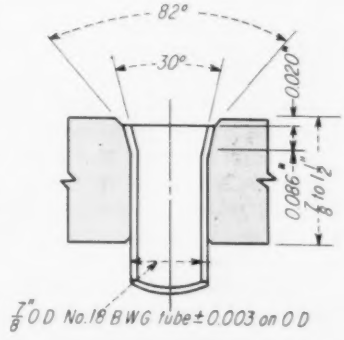
Running the test. Test assemblies and general work area are shown in Fig. 2. Simulated heat exchangers are in completed state with

(*Continued on page* 196)

These joint designs are used for all welds



5 This joint welds the admiralty metal and arsenical copper to naval brass



6 Aluminum-brass tubes are welded to naval-brass tube sheets with this joint

Follow these methods for condenser testing and operation

Here's how to measure pressure and temperature, calculate amount of circulating water and run condenser tests; plus info on the three basic factors in condenser operation

By DONALD SWIFT, Ebasco Services Incorporated

Having considered the types of condensers, the circulating-water system and the procedures for handling condensate in the last three articles of this series, we now continue our discussion with information on testing and operating the condenser.

Condenser testing should follow the procedures and precautions given in the applicable ASME test code. For accuracy, you need a complete heat balance check of the entire plant, particularly if there is no condensate flowmeter. Estimate steam to condenser by measuring steam flow to turbine and subtracting amount extracted for feedwater heating or other purposes. Estimate extracted steam quantities by working up a heat balance in the feedwater heating cycle.

If you have a condensate meter, you can closely approximate heat input to the condenser by multiplying weight of condensate by 950 Btu per lb. The usual difference between heat in exhaust steam to the condenser and heat in condensate leaving the condenser is within 1 or 2% of that figure, regardless of the absolute pressure under which test is run.

Here's a shortcut to avoid taking data for a complete heat balance: use final feedwater temperature to indicate amount of heat extracted from the turbine. Net heat to the condenser equals heat in steam to turbine throttle plus that added in the reheater, if any, plus that added in the boiler-feed pump, minus heat in feedwater leaving the final feedwater heater, and minus the heat equivalent of power output from the turbine or generator.

Feed-pump input power equivalent (Btu per hr) is taken to be .003 times water flow (lb per hr) times discharge pressure (psi) at the final heater. Generator output heat equivalent in Btu is 3413 times kw generation divided by the product of the mechanical and generator efficiencies of the set.

Pressure measurement. Because of variations in velocity as exhaust steam leaves last-stage turbine wheels, the velocity and hence the pressure or vacuum in various parts of the exhaust neck may vary by several tenths of an inch. Braces and other obstructions in the exhaust neck may cause eddies or flow disturbances. For official testing, use enough pressure test points so there is at least one point for each 16 sq ft of exhaust-neck cross section. Use flat guide-plates to insure that steam flow is at right angles to ends of the pressure-sampling taps, which are set flush with exhaust neck wall or inner surface of one of the guide plates.

Pressure is usually measured near end of the turbine-exhaust neck, where effect of bracing or changes in cross section have a minimum effect. For side-entry condensers, where the steam must take a right-angle bend on its way from turbine exhaust to condenser, you may have to place test points near the condenser. Turbine and condenser performance guarantees are generally understood to include the portion of the exhaust neck furnished, so point of measurement should be as close as possible to the junction point.

Temperature measurement. It's advisable to install one or more long test wells that will permit use of accurate mercury-filled thermometers to measure steam temperature. The wells should be in a portion of the flow area that is representative of average velocity conditions, and should be set so the well may be

filled with water. This gives better heat transmission to the thermometer.

Take condensing-water temperatures at the inlet and outlet of each circulating-water connection using accurate thermometers. Water in outlet pipes may be stratified, so it is advisable to install three or four thermometer wells around the pipe to get an average temperature. Inlet water is usually well mixed, so one or two temperature-measuring points at each inlet is sufficient. These wells should extend six or eight inches into the pipes to sense water temperatures properly. Where possible, slope the wells so they can be filled with liquid for more sensitive readings.

Measuring the exhaust steam and condensate temperatures indicates the amount of subcooling in the condenser, and gives a check on absolute pressure measurements.

Quantity of circulating water is difficult to determine. The most usual, and probably the most accurate, method is to divide the Btu absorbed in the condenser by the average temperature rise in the circulating water to calculate the weight of water flowing. Temperature rise must be determined carefully.

Another method uses two pitot tubes set at right angles to each other at some point in the circulating-water pipe run, following a long straight section. A complete and careful traverse of pipe diameter at rather close intervals is necessary to get an accurate flow indication. Occasionally it is feasible to install an orifice and pressure taps in the circulating-water line. But this introduces a continual pressure loss that may be objectionable.

Circulating-water-pump head and power input is often determined at the time of condenser tests. Comparing these values with the manufacturer's shop test curves may confirm or cast suspicion on flow quantities determined by other methods. For accurate values, observe these precautions: (1) Correct indicated static pressure for velocity head. (2) Give proper weight to the effect on flow and temperature rise of any water-using circuits paralleling the condenser flow, such as oil coolers, hydrogen coolers and other auxiliary cooling elements. (3) Consider the effect of introducing cold makeup water at some point in a cooling-tower system.

Running the tests. Run tests of condensers and auxiliary equipment with clean tubes and in accordance with appropriate ASME test code instructions. Conditions should be as close as possible to guarantee conditions. If turbine load can be blocked or held at a steady value, and if circulating-water suction and discharge-level conditions are quite stable, the test can be short—not more than an hour or two. In any case, hold conditions as steady as possible.

Take care to observe levels of hotwell and other condensate-storage reservoirs at the start and end of tests so you can make appropriate corrections of flow values where necessary.

Test instruments should be carefully calibrated before or after the test—preferably before. For accurate results, use a mercurial barometer that has been compared with a standard barometer at a Weather Bureau office. Hang the two instruments side by side for a time.

The mercury type vacuum column must be in the same room as the barometer, especially where the room is under pressure from air conditioning. Different ambient temperatures or elevations also affect the readings so you may have to make corrections for these factors.

Carefully zero barometers and vacuum columns at each reading, and take the readings at the top of the mercury column. Take enough readings of all test values to get a good average. This eliminates the effect of momentary variations or errors in reading the various test instruments. Using sufficient help to allow readings to be taken frequently and nearly simultaneously aids test accuracy.

Condenser operation. Efficiency of surface-condenser operation involves three basic things: (1) maintaining heat-transfer surface cleanliness (2) adjusting water flow for best economy (3) reducing air leakage to a minimum. These three requirements are mutually helpful in obtaining maximum plant economy.

Clean tubes keep resistance to heat transfer at a minimum. Thus, for a given circulating-water temperature the steam and condensate temperature on the other side of the tubes is as low as possible; turbine-exhaust pressure is down, and turbine output for a given steam quantity is a maximum.

Tube cleanliness depends on the circulating-water supply. If the water carries much silt and sand—as in the Missouri River, for example—the tubes may be polished clean without any attention, although they may have a short life because of erosion. With most waters, algae growths tend to build up on the tubes, especially when water is warm.

Intermittent chlorination of circulating water seems to be the most effective way to fight algae. This was discussed more fully in article No. 23 of this series, POWER, May 1956, p 88. The algae often serve as a binder for mud or scale; hence if algae deposits can be eliminated other deposits may be minimized as well.

In a once-through water system, scale deposits are not likely to form. But in closed systems, such as cooling towers and cooling ponds where the water is concentrated by evaporation, scale deposits may be expected if the water is not chemically treated or if dissolved solids concentration becomes too high.

Some scale deposits develop gradually on condenser tubes as a result of a chemical balance that gives a positive Langelier index. These may be gradually removed by altering treatment and blowdown procedure so as to carry a slightly negative index. But don't overlook the possibility of increased metallic corrosion in other parts of the circulating-water system. The condenser tubes may be the most noble metal in the circulating-water system, and may show a tendency for scale deposition when other portions of the system are undergoing light corrosion. (*Continued on page* 202)

DISCHARGE TUNNEL, now under construction, and open canal, beyond bend, will take water on the 1.5-mile trip back to the Mississippi River main course, *top*

Two-mile cooling-water circuit avoids recirculation at Memphis

To prevent using hot cooling water and to live with widely fluctuating river levels demanded solving some unconventional problems for a power plant circulating-water system

By D H KREGG and S J WESTON
Burns and Roe, Incorporated

Three 250-mw 2400-psig 1050/1050-F units are being installed at the new plant of the Memphis Light, Gas and Water Division of Memphis, Tenn. These will have six circulating pumps pushing 381,000 gpm of cooling water through the condenser circulating-water system at about 5 mph.

Sketch, p 101, shows layout of the system starting with six 1250-hp Worthington pumps standing outdoors at the river's edge and driven by 4160-v synchronous Elliott motors. These deliver water to a poured-concrete manifold at up to 57-ft total head. From here the water leaves for the main condensers through two 10-ft-dia concrete pipes, a second manifold in the plant, and individual tunnels connecting the three condenser inlet waterboxes.

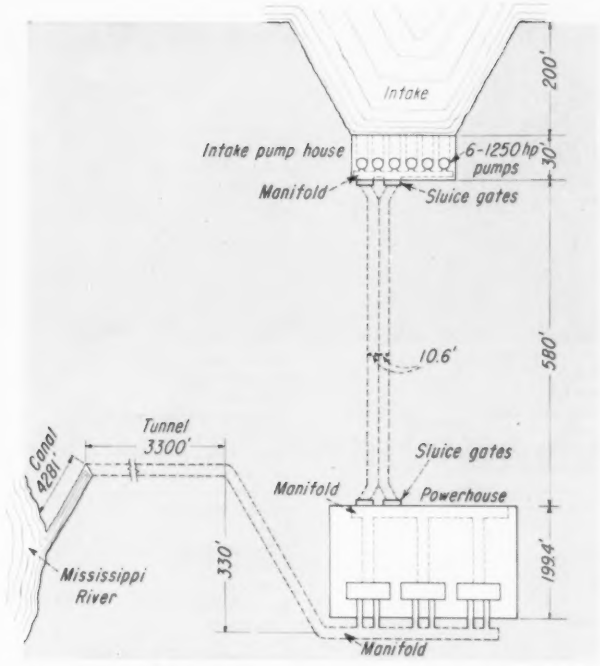
Condenser discharge collects in a third manifold, 10-ft wide and 15-ft 10-in. high. At the end of this manifold the first of two seal wells prevents loss of siphon during low-level stages of the Mississippi River.

Between first and second seal wells the water travels about 4000 ft through two poured-concrete tunnels, about 12x12-ft cross section. At the second seal well the water cascades over a weir to enter a 4300-ft open canal. The water travels almost two miles through this entire circuit.

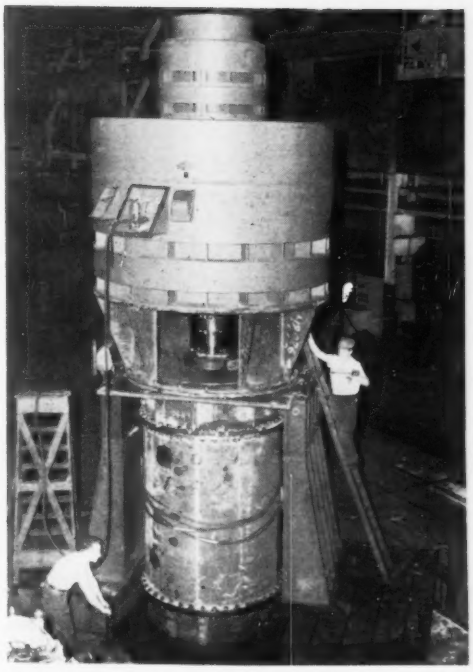
Why this arrangement? The plant stands opposite an island on an inlet with little water motion. To discharge warmed cooling water into the inlet would let it recirculate through the condensers and so raise the backpressure of the main turbines. To avoid this, the water has to be discharged back to the main river where the current would prevent recirculation to the water intake.

This led to building the tunnel and canal shown in photo, above. The tunnel is long enough to extend outside a levee being built around the river-bottom land adjacent to the plant. The levee will prevent flooding the area during high river stages.

Siphon head. This system needs careful engineering to minimize the pumping load and investment. The cooling-water circuit incorporates a 27-ft siphon head. Out of a total maximum head of 81 ft (44-ft static and 37-ft frictional losses) 54 ft must be supplied by the pumps, less as the river stage rises. At highest stage the water flows by gravity and pumps



CIRCULATING-WATER ROUTE at Memphis starts at intake on inlet having little water motion, ends at outfall on main course of river, *left*



CIRCULATING-WATER PUMP, an outdoor type, on test stand handles about 63,500 gpm against 57-ft head

supply only the system friction heads.

Water hammer. A system of this length must be guarded against water hammer. Should the pumps stop suddenly, momentum of the water will carry it forward through the piping. But water in the pump suction intakes would flow back toward the river causing water-column separation somewhere in the system. The high vacuum in the separation eventually makes water reconverge with destructive shock or water hammer.

To avoid building up these destructive stresses, vacuum-breaking valves have been installed along the entire system at all points of potential water-column separation. When pipe vacuum drops below its normal level the valves open and admit air. This acts as a cushion to soften the impact of the water columns.

An air-removal system bleeds off this admitted air when the system returns to normal. It also removes any dissolved air normally released by the water at points of subatmospheric pressure in the system.

Outdoor pumps. The pumping station stands on a continuous concrete slab, weatherproofed for outdoor operation. At high river stages only three pumps are needed to supply water to the three main condensers. At the lowest river stage all six pumps must run. The Mississippi River has a 59-ft rise between low and high stages.

Pairs of pumps, with total capacity of 127,000 gpm against a 57-ft head, stand in single pump-pit sections of the intake structure. This allows isolating the pumps in pairs by closing sluice gates at the section intake for dewatering.

As we said, the pumps connect to a manifold and deliver their water to the condensers via two 10-ft tunnels. Each tunnel can carry enough water to serve two of the three main condensers. Eventually, Memphis may have six 250-mw units so one more 10-ft tunnel will be needed.

The 4000-ft discharge tunnel, on the other hand, will be able to carry the cooling water discharged by six main condensers. The distance involved is so great that the designers found it more economical to invest the additional funds now, rather than build an additional tunnel later. Anticipating future expansion, knockout walls and sluice gates on all manifolds will allow continuing operation during enlargement construction to handle the three additional units.

Bearings — lubrication. Pump impellers cast of aluminum bronze will resist the erosion of the high-solids content of Mississippi water. The stainless-steel pump shafts will be 6 in. diameter.

Filtered water lubricates the circulating-water-pump bearings. Auxiliary pumps force the lubricating water down along an inner 12-in. casing surrounding the pump shaft. This water mixes with incoming river water to be drawn up into the 66-in. cast-iron pump barrel. Eleven rubber bearings guide the pump shaft laterally; a Kingsbury thrust bearing mounted at the motor drive supports the shaft weight.

A trash rack, consisting of steel bars on 5-in. centers, mounted at the intake structure water inlet guards the pumps against floating debris. Traveling water screens behind the rack take out finer debris.

The British say it differently

By J M TOTTEN, Boston, Mass.

While leafing through your mail this morning suppose you came across the following in a letter postmarked Huddersfield, England:
"Our works informs us that whilst under the terms of our tender we are required to dispatch to you on 18 March 1958 six (6) steel open tundishes for use on your three electro-feeders, they are unable to do so because of etc, etc. . . ."

Would you be able to translate this into: *"We can't ship on schedule six sight-flow funnels for your motor-driven boiler-feed pumps, because etc, etc. . . ."* You, in effect, need a glossary of terms to find out what is being said. In reading through the listing, *right*, we must admit that many of the British technical terms are more descriptive than their American counterparts.

The British do not have turbine-generators; they do have *turbo-alternators*. They are not attended by an operating crew, rather, the *driving staff* has charge of them. In this country we speak of a turning gear whereas in Britain it is referred to as a *rolling gear* or *barring gear*. The latter term must have been passed down from the days of the reciprocating engine.

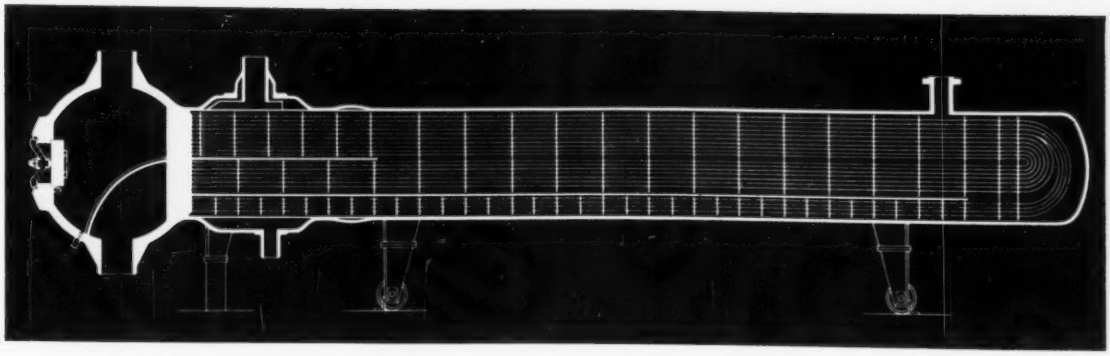
Across the sea they prepare tracings in a *drawing office* not a drafting room and the work is *put in hand*, never commenced. Where we refer to structural costs they speak of *civil costs;* our building columns become *stanchions* overseas.

Everyday power terms for mechanical engineers

U.S.A.	United Kingdom
Hotwell pump	Extraction pump
Heater-drip pump	Drains pump
Motor-driven boiler-feed pump	Electro-feeder
Turbine-driven boiler-feed pump	Turbo-feeder
Two-stage pump	Twin-series pump
Deep-well pump	Bore-hole pump
Triplex pump	Three-throw pump
Pump governor	Pump control valve
Turbine stop valve	Runaway valve
By-pass valve	By-pass valve
Vent valve	Air cock
Discharge valve	Delivery valve
Main steam stop valve	Isolating valve
Air-vent valve	Air-release valve
Admission valve	Relay valve
Rising-stem gate valve	Valve with extended spindle
Sleeve valve	Plunger valve
Boiler nonreturn valve	Automatic isolating valve
Atmospheric relief valve	Automatic exhaust-relief valve
Constant backpressure valve	Surplus valve
Double-disk gate valve	Parallel slide valve
Valve-stem guide	Bush
Valve yoke	Pillars and bridge
Lifting lever	Easing lever
Valve bonnet	Valve belt
Valve stem	Valve spindle
Floor stand	Floor column
Ring gasket	Joint washer
Thrust bearing	Thrust block
Pillow block	Plummer block
Shims	Liners
Stem leakoff	Neck-gland drain
Extraction steam	Bled steam
Oil passages	Oilways
Blade rub	Shroud contact
Leakoff chamber	Leakoff belt
Bearing cap	Bearing keep
Hollow setscrew	Grub screw
Blade ring	Blade carrier
Blade anchorage	Root fixing
Initial pressure regulator	Pressure-operated unloading gear
Low load limit	Antimotoring device
Spanner holes	Tommy holes
Distilled-water tank	Reserve feed tank
Flash tank	Drain pot
Waterbox	Waterway
Drum nozzle	Boiler stool
Internal-gear type flexible coupling	Muff coupling
Main steam header	Main steam range
Pipe dope	Jointing compound
Lip of outlet nozzle in tank bottom	Upstand
Metal lagging	Cleading
Thermometer well	Thermometer pocket
Orifice	Nozzle or diaphragm plate
Sight flow-drain funnel	Open tundish
Tube sheet	Tube plate
Tube bundle	Tube nest
Start-up	Run-up
Hydrostatic test	Hydraulic test
Field weld	Site weld
Minimum tensile strength, psi	Maximum stress, tons per sq in
Installing	Fixing

Electrical engineers have their differences too

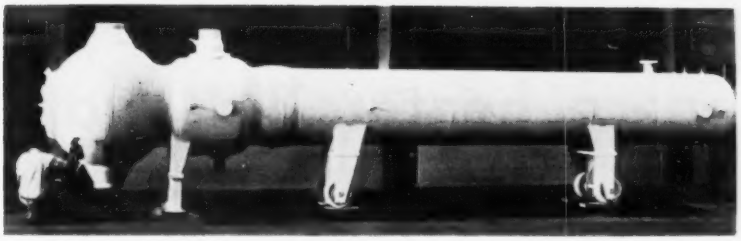
Grounded	Earthed
Variable resistance	Dipper
Brush rigging	Brush gear
Collector rings	Slip rings
Generator-rotor retaining rings	End caps
Electric horn	Hooter
End bells	End covers
Moisture indicator	Liquid alarm
Synchronizing screw	Governor regulator
Load rejection	Lead throw-off or off-loading
On the line	On the bars
Storage battery	Accumulator



Spherical-head feedwater heater...

avoids possible leakage problems, hold down maintenance costs

By A E PICKFORD and J M PHELPS
C F Braun & Co



Rising pressures and temperatures in modern power stations demand high dependability of heat exchangers. Many new plants run with feedwater pressures as high as 3400 psig, and at least two superpressure plants will use 6500 psig. Feedwater heaters with conventional gasketed closures need special attention to stay tight at this upper level and may cost more to maintain.

The new spherical-waterbox all-welded heater designed to avoid leakage and high maintenance will be installed in 16 new central stations. The spherical waterbox, integral with tube sheet and heater shell, has ample room for a workman inside. A pressure-sealed manhole, with a cover hinged inwardly, gives easy access. Pressurized feedwater seals manhole cover against spiral-wound gasket.

Avoiding use of flanges and bolted joints eliminates potential leakage. The spherical shape needs least material and can best withstand thermal-shock stresses from quick start-ups and sudden outages.

The all-welded sphere, shell and tube bundle parts are mostly welded automatically, radiographed and stress relieved. Heaters can be installed horizontally or vertically with head up or down.

Eight of these heaters serve new units in the Astoria and Arthur Kill Stations of the Consolidated Edison Company of New York, Inc. Each of the new boilers produces 2,400,000 lb steam per hr. Forty-one heaters are underway for plants of the Pacific Gas and Electric, Louisiana Power and Light, Houston Lighting and Power, Commonwealth Edison, Philadelphia Electric, Holyoke Water Power, San Diego Gas and Electric, Consumers Power Companies and Central Hudson Gas & Electric Corp.

Con Edison's high-pressure heaters have spherical waterboxes of 5 ft diameter and 2⅞ in. thick, see cross section above. The 3000-psi feedwater makes two passes through the U-tube bundle. A curved pass-partition plate separates inlet and outlet passes in the sphere. The curved plate accommodates thermal expansion and can be removed through the manhole.

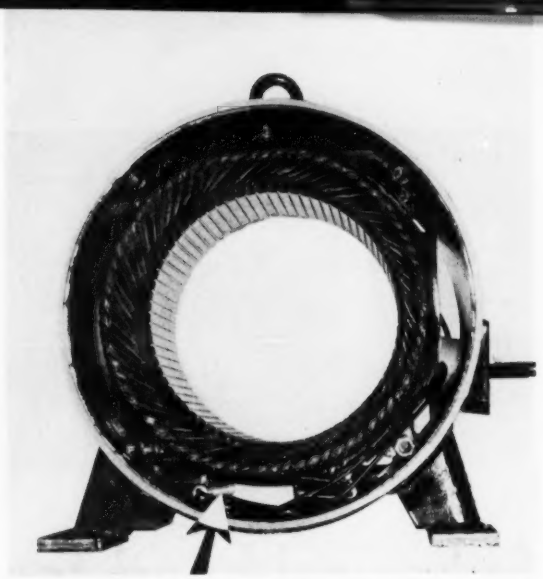
The tube sheet, an integral part of the sphere, is about 4 ft dia and 10 in. thick. Tubes are ⅝-in., 18-gage Monel nickel-copper. Tube bundles are about 40 in. dia and 30 ft long. Each heater holds 7700 sq ft of heat-transfer surface. Each U-tube is stress-relieved and tested at double design pressure after bending to shape. Tube ends are welded into tube sheets. After inspection and inert-gas and hydrostatic tests, the tube joints are expanded to protect the weld against tube vibration. Tube joints are again tested by inert gas from the shell side. After assembly both sides of heater are subjected to ASME Code hydrostatic tests.

Nozzles for steam inlet and condensate outlet are welded to an enlarged section of the shell called the *annular distributor*. These allow considerable freedom in orienting the nozzles in any position without interfering with the tube-bundle internal arrangement. Distortions from welding the heavy nozzles are taken by the distributor —main shell remains perfectly round.

Stainless- (*Continued on page* 190)

By R L NAILEN, Motor Engineering Dept
Westinghouse Electric Corporation

Circulating a small current through the coils may be practical for small motors but in the big units, separate . . .



CARTRIDGE HEATERS, available for various mountings, are usually rated in the 50- to 150-w range for use on 115 or 230 v

Space heaters lick motor moisture

Moisture is insulation's enemy and a constant threat to motor reliability. So when you can, avoid exposing motor windings to temperature changes that allow condensed water to collect. While a motor is running, the combination of air circulation and temperature rise because of motor losses, is sufficient to keep windings dry. Remember, the purpose of space heating is to maintain motor windings at a temperature slightly above the surrounding ambient, thereby effectively preventing condensation during a shutdown.

Prime applications for space heating occur where: (1) motors are outdoors, such as *weather-protected* motors and temperature variations may be extreme (2) totally-enclosed motors are exposed to severe moisture conditions as are found in many industries. Unusually high humidity aggravates the problem, as does a duty cycle with infrequent motor operation.

Space heating may be handled by: (1) circulating a low current through one phase of 3-phase winding, thus developing heat without causing rotation (2) providing separate heaters inside motor enclosure which, in turn, are energized from an outside source. First method generates heat in windings directly; it's more accurately termed *winding heating*. Second method warms windings indirectly by convection.

The first method is often used for small motors in the 1- to 30-hp range, where enclosure compactness makes it difficult to fit in a separate heater. Single-phase current required is about 30% of rated motor current and is circulated by 5 to 10% of rated voltage. Such an arrangement requires a small transformer to reduce line voltage in addition to necessary circuit control components.

Separate heating technique utilizes several type heaters. One is the *cartridge heater*, a compact unit of tubular construction, available for various mountings. These are usually rated in the 50- to 150-w range at 115 or 230 v. A second is the ***strip heater***, larger in size and better adapted to heating large spaces. These are available in ratings from 150- to 1500-w per heater at the same voltages.

Strip and cartridge heaters have a resistance element encased in refractory material and enclosed in a metal sheath. They resist the shock and vibration normally encountered in motor applications. They are generally provided with screw terminals for lead wires; however, the cartridge type may be obtained with self-contained leads.

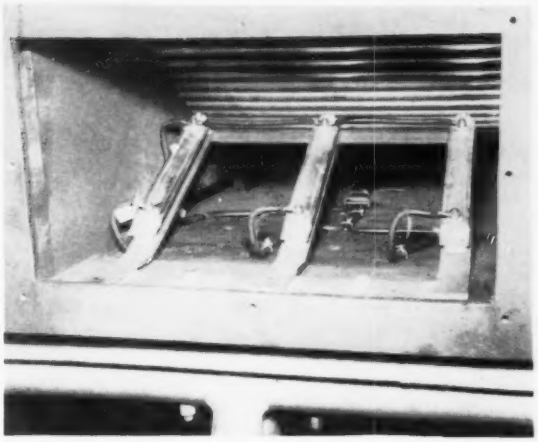
When either of these types are used, they shouldn't touch windings or motor leads—heater surface temperature may approach 1000 F, depending upon air circulation around the heaters.

A word of caution regarding heater surface temperature: Dripproof or weather-protected motors are frequently used in pumping service on petroleum pipelines. A conventional space-heater installation in such a motor may have surface temperatures above the ignition point of vapors (such as gasoline). So when ordering a motor for such service, specify the application. Motor manufacturer can then provide safe heater temperatures by installing more heaters than usual and connecting them so voltage on each heater and resulting surface temperature will be reduced to a safe level.

On small machines with cylindrical frames, heaters are usually between outer frame shell and stator iron; on vertical motors they may be in lower bracket to take advantage of convection in circulating the heat. In large motors, heaters are in bottom of frame, between motor feet.

Since heaters and their connections

COIL TYPE space heater can be wrapped around stator-end turns, then lashed to winding. Leads are brought out to separate box



STRIP HEATERS are suited for use in large spaces. They can be had in ratings from 150- to 1500-w per heater at 115 and 230 v

may fail from thermal cycling and corrosion, they must be accessible for servicing from outside the motor. Access covers in the frame may be provided, or in some cases heaters can be reached through normal vent openings. Space limits in small motors usually make it necessary to remove a motor bracket to reach heaters. However, for machines in NEMA frame sizes this is not a major operation. Some typical installations are shown above.

Third type heater develops heat directly adjacent to motor windings. This is the shuttle or *coil-type heater*, basically a flexible loop of insulated resistance wire, wrapped directly around motor end turns and lashed in place. Heater surface temperature is kept low to avoid winding damage. The coil-type heater requires only one-fourth as much power as strip or cartridge heaters for the same size motor.

Any of these three heaters may be connected in series-parallel arrangements to make up necessary wattage and voltage needs. It's up to you to specify heater voltage and whether a single- or 3-phase heater connection is desired. Motor manufacturer then determines wattage necessary to provide sufficient heat for motor enclosure.

Normally, a 3-phase supply voltage is not recommended where the heater output rating is below 100 watts.

Single-phase ac power is most often used for heater circuits—the basic 120- and 240-volt levels are the customary potential limits. But where motor hp exceeds 150, 480 volts becomes a likely candidate.

When considering a motor with heaters, it would be most practical to specify this voltage. Some small cartridge heaters have insufficient insulation to ground for series connection in a 480-v circuit.

A common means of heater control is through a manual switch in the heater circuit. Heaters may be left energized continuously, turned on whenever the motor is shut off, or switched at the operator's discretion. This can waste kwhr, and does not insure heating will be working when needed.

Another method is through automatic controls sensitive to temperature or humidity changes within motor enclosure. These energize heaters whenever dangerous moisture conditions exist. Although this results in minimum heater power usage, it is not generally adopted because of initial cost and maintenance.

A practical approach for large motors in unattended locations is to use an auxiliary contact on motor starter or circuit breaker which energizes heaters whenever motor is taken off the line.

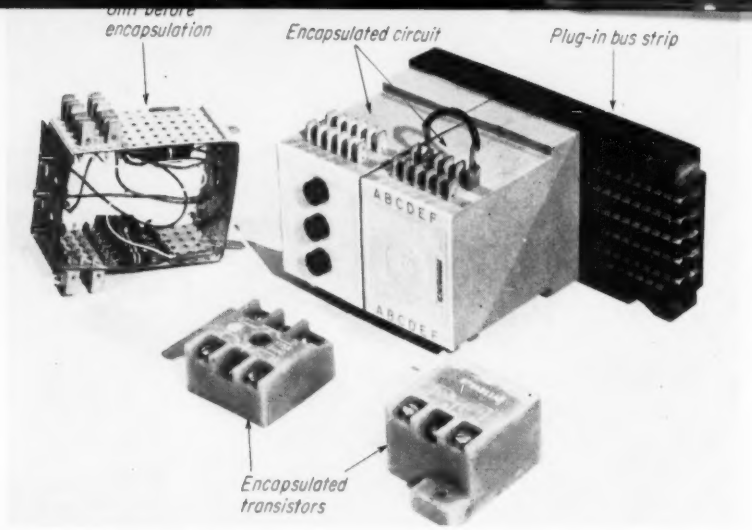
A rough figure to use when estimating power requirements for strip- and cartridge-heater installations is *one watt of heater power per hp of motor rating*. This will change somewhat for various motor speeds and type of enclosures.

Correction

Two typographical errors crept into our story on flyash collection at the E F Barrett Station (Jan 1958, p 90). In the second paragraph of the third column, the description of the Buell dust-collection system indicates that the first-stage unit is made up of "*4% cyclones*," and the following sentence has *each bank divided into six groups of "cylinders."*

The "*4%*" should, of course, be "*48*," and the "*cylinders*" should be "*cyclones*."

By W E CRONQUIST
General Electric Co



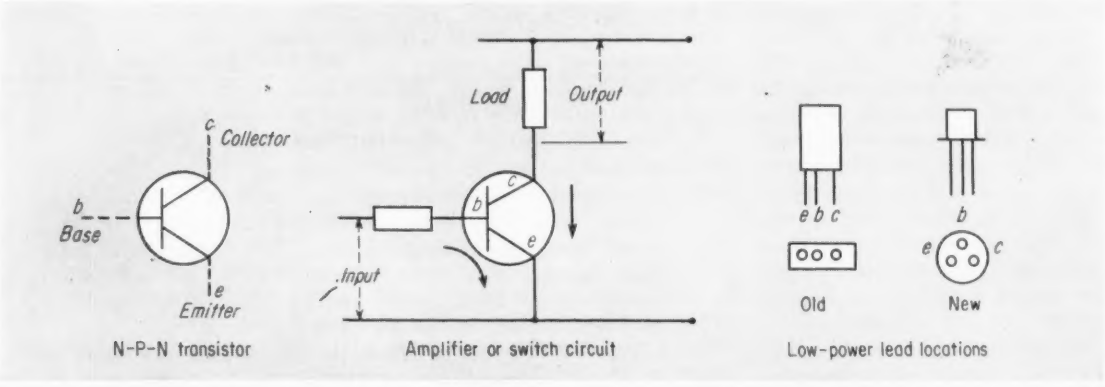
ENCAPSULATED TRANSISTORS make rugged, easily maintained electronic control parts. A plug in circuit, such as an amplifier, cuts downtime for troubleshooting and repairs

Transistors play a growing part

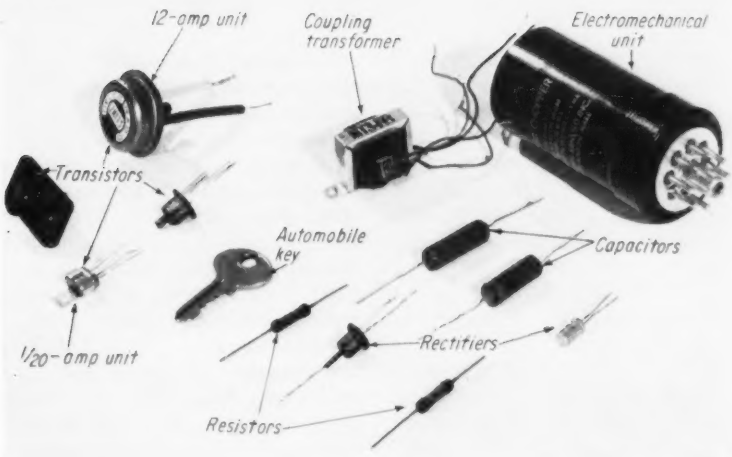
Transistors have established themselves in the industrial power field, and the odds are you'll have transistorized equipment in your plant within the next few years. Story behind this move can be put into one word: *reliability*. Since the first crude unit in 1948, transistor manufacturers have improved their products so that one company actually tumbles completed units in a rotary barrel before making electrical tests. This inherent mechanical ruggedness, together with electrical ruggedness designed into specific applications, will enable transistors to find numerous important industrial applications.

Most obvious applications are direct substitutions of transistor circuits for electron-tube circuits in machine-drive regulators such as found on paper machines, hot and cold steel-strip mills, engine dynamometers, gas and steam turbines, etc. Along these lines will be uses in recording and controlling instruments such as dew-point recorders, vibration meters, temperature and flow controllers, etc. In short, most places where an electron-tube amplifier is used at present.

More interesting than increased reliability are characteristics which permit transistors to do things for which tubes are not suited. The concept of a transistor as an on-off switch is just beginning to gain its rightful place of importance in industrial equipment. Static, or contactorless, switching systems have always been a dream of plant engineering and production people. Transistors, now available, can switch 1000 watts



STANDARD SYMBOLS recommended by Radio-Electronics-Television Manufacturers Association for schematic diagrams. Emitter arrows are reversed for P-N-P transistors. Simplified typical amplifier or switching circuit is represented by diagram in the center



TYPICAL TRANSISTORS and components for present-day electronic industrial control. Reliability and long life are in their favor for industrial applications instead of tubes

in industrial control

of power at speeds above 100,000 times a second.

Theory of conduction in solids can't be taken up in this article. To intelligently install and maintain transistorized equipments, however, you should be familiar with at least the fundamentals of operation and what the characteristic curves mean —refer to POWER, Dec 1956, p 134, and to transistor manuals put out by manufacturers. Symbol for N-P-N transistor (standardized by Radio-Electronics-Television Manufacturers Association—RETMA) is shown at bottom of p 106. In very rough terms the emitter corresponds to a tube cathode, the base corresponds to the grid and the collector corresponds to the plate.

In transistors it is normal to speak of currents rather than voltages when discussing its functions. Thus we say that a small current flowing from the base to the emitter will control a large current flowing from the collector to the emitter. A single simple amplifying stage is shown. A switching circuit would look the same with the current flowing from the positive bus through the load and the transistor to the negative bus controlled by the transistor. With zero current flowing into the base, transistor will present up to several hundred thousand ohms resistance. With maximum current flowing into the base, resistance would be somewhere from several ohms to several hundred ohms depending on the particular unit.

Composition of transistors accounts for their ruggedness. They're composed of a material similar mechanically to quartz, a small amount of which is welded to rigid lead mounts. The whole assembly is hermetically sealed inside a metal can about the size of a thimble. Hermetic sealing is necessary because the material inside is adversely affected by contamination from the atmosphere. Once the unit is finally assembled there are no critical spacings as in a vacuum tube, and there is no heated filament to deteriorate and eventually burn out. Some typical transistors are shown in photo above.

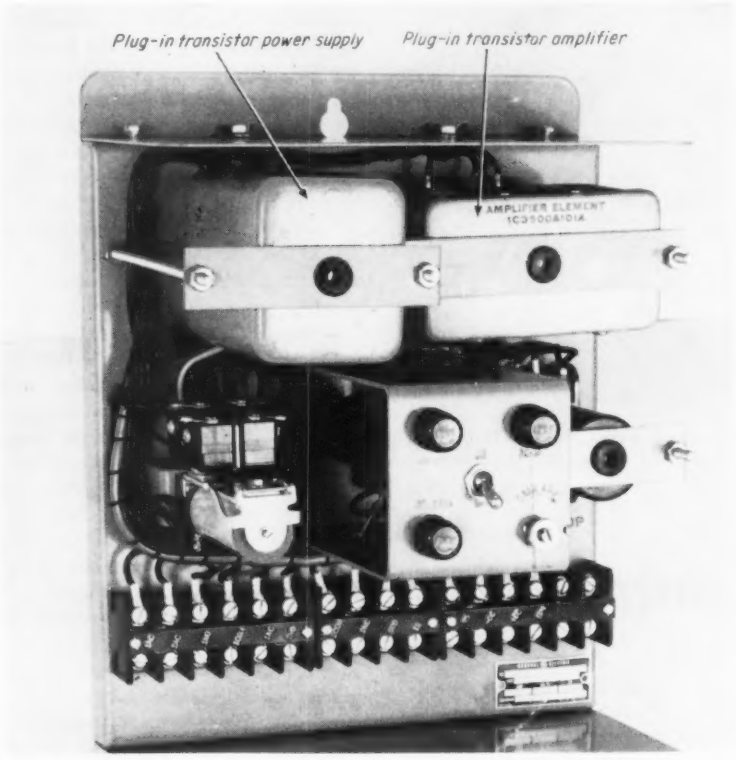
To obtain overall ruggedness we must also have electrical ruggedness. As with any device, transistors have maximum ratings. Because of their extremely small physical size, their electrical overload ability is practically zero. The circuit designer must stay within the manufacturer's rating so as to provide electrical ruggedness. Transistors are normally much more conservatively applied than are vacuum tubes.

Transistor amplifiers you'll see in industrial equipment can be roughly broken down into dc, ac and switching. We separate switching applications because they're usually limited to the more unique cases. Transistor-amplifier schematic diagrams look quite similar to electron-tube schematics, and should not be difficult for the trained maintenance man to understand. A few general differences will be obvious.

Transistors operate on much lower voltages, 10 to 50 volts being a common collector voltage range. Base voltages are extremely low, being anywhere from several millivolts to several volts. Base currents may be from a microampere to several milliamperes. Current gains run from 1 to over 100. Typical figures are shown in table, left. **Turn page**

Contrast of characteristics of typical low- and high-powered transistors

Characteristics	Low power	High power
	2N43	2N174
Maximum voltage, volts	45	80
Maximum current, amperes	0.05	12
Current gain, common emitter	50/1	40/1
Off resistance, ohms × 1000	4500	60
On resistance, ohms	100	0.05



CONTROL PANEL, a small special-purpose type for ho' metal detector. Plug-in encapsulated power supply, *upper left*, is for plug in transi ,or amplifier element, *upper right*

PORTABLE TESTER used for field servicing of transistors of industrial drives. Meters read base and collector currents while the rotary switches select the resistance values

Temperature sensitivity is probably transistors' biggest limitation; their characteristics vary as the internal temperature changes. Circuits are available which partially or wholly compensate for this at expense of simplicity and cost. Very-high-gain dc amplifier will drift with temperature to the point of uselessness under certain conditions. In very-high-gain or high-accuracy applications you may see an ac amplifier used even though the inputs and outputs are dc. This is done by "chopping up" the dc into a 60- or 120-cycle square wave whose magnitude varies as the dc input level. This amplitude-modulated wave is then amplified in an ac amplifier and rectified at the output. Ac amplifiers drift as much as dc amplifiers, but it is of little matter so long as the amplitude variation is not lost. Some components you will see used are grouped on the right in photo, p 107, including an electromechanical "chopper."

Control manufacturers are well aware of industry's desire for design and packaging of equipment for ease of maintenance and reliability. Some efforts in this direction are shown at top of p 106. Small block in foreground consists of two transistors encapsulated in epoxy resin with screw terminals to accept standard pressure-type wire terminals, and with creepage barriers to give standard NEMA clearances to ground. Catalog number and graphic symbol appear on front in white-filled letters. The resin block gives a convenient way to fasten transistors to a metal base in a layout wherein circuit is built up by mounting resistors and other components on screw-type terminal boards and strips. This has advantage of individual part replacement and availability of all points for servicing.

Where downtime costs are high in comparison to control equipment cost, packaged plug-in amplifier sections are built in quickly removable modular sizes. Components necessary for one functionally independent amplifier element are mounted on a standard-sized fiber base and then encapsulated in a lightweight foam plastic. This renders the components immovable. Stab terminals on back engage plug-in buses which carry fixed power voltages. Stab terminals on the top and bottom provide for input and output by means of a fast push-on

connector. Where required, test jacks can be provided on front to enable rapid trouble shooting.

With a full line of such standardized elements, designers have only to combine to meet specific application requirements. Such modulizing has advantage in addition to rapid maintenance of making diagrams more uniform and complex systems easier to understand by sectionalizing the functions. A more subtle advantage is the mechanical compatibility with other components of a given manufacturer. Thus static switching systems and modulized amplifiers may be functionally arranged on the same panel giving uniform appearance and minimum stocking of common replacement parts. System expansion or modification is simplified.

A third but similar concept of easing maintenance can be applied where the function is a simple or very special-purpose one, and cascading of amplifiers is not necessary. Photo, p 108 shows this concept applied to a hot-metal-detector control panel. Upper left block is a regulated transistor power supply sealed in a steel enclosure with a standard 8-pin plug engaging a socket. This supplies power to specialized transistor amplifier, which is also encapsulated in a steel enclosure with a standard 8-pin plug. At extreme right edge notice top of a mechanical reed "chopper," part of the overall system.

Modulizing, or unit packaging for rapid maintenance and simplified design is more readily accomplished with transistors than with vacuum tubes. Their much smaller physical size and very low internal power dissipation, plus the fact that theoretically a perfect transistor has no reason to fail (no critical spacings nor heated element), makes them attractive. It should be emphasized, however, that responsibility for transistor reliability has shifted from the transistor manufacturer to the circuit designer, and the purchaser should insist on and expect proper designs.

Plant maintenance supervisors will need to take a logical approach to transistorized equipment, but this does not mean that completely new techniques are required. For instance, many maintenance men are accustomed to ringing out circuits with a 3-volt bell set. Others use a sound-powered telephone or a portable ohmmeter on the low (X1) scale.

None of these methods should ever be used on circuits incorporating small-sized transistors, diodes or photocells. As pointed out earlier, the transistor is simply two small rectifiers back to back with a common center point. The current which could flow in the forward direction from any of these test methods could exceed by many times the current ratings of smaller transistors. If a portable ohmmeter must be used, employ the higher (X1000) scale.

When measuring voltages, a voltmeter with a high input impedance should be used, since the current drawn by the meter movement could overload the circuit elements, or cause a loading effect in the high-impedance circuits which would lead to erroneous readings. A much faster, safer and more accurate testing device can easily be built or purchased.

A transistor tester built by one control system manufacturer for both design testing and field servicing is pictured at bottom of p 108. This is a completely self-contained unit in a small suitcase. Two meters read base and collector currents (not voltages), and rotary switches select resistance values as required.

Large power transistors are not usually encapsulated because materials don't allow dissipation of internal heat losses. In this case mounting is very important. Data sheets compiled by manufacturers usually assume that the unit is mounted on an ideal heat-dissipating base. Proper design of this base (perhaps the circuit chassis or a copper fin) is up to the designer, but the maintenance man must be aware of the mounting problems when he replaces a unit after testing.

Use of silicon grease between unit and base is usually recommended to obtain proper heat transfer. Omission of grease may increase resistance to heat flow by a factor of five or more, and lead to burnouts or shortened life. The mounting bolt should be tightened firmly, but not overly tightened. Torques from 50 to 200 inch-ounces are usually recommended.

When circuit modifications are made, effects of additional heat-generating devices should be closely watched. For encapsulated transistors, the rise in ambient temperature caused by addition of transformers and resistors is the main point to be watched. For power transistors mounted on a cooling fin, this, plus added factor of heat radiated directly to the fin by a nearby power device, must be considered. For power transistors using the chassis as a heat sink, the above two factors, plus additional problem of heat-generating devices raising chassis temperature itself by conduction, must be considered.

Temperature problems involve two distinct factors. We've talked about absolute temperatures causing burnouts or short lives. Assuming proper original design, it's up to the purchaser to operate the equipment within its various ratings, including that of absolute ambient temperature.

Most industrial equipment is rated for continuous duty in 40-C free air. If applications in very high ambient temperature locations are necessary, you must so inform the supplier, and his designer will either derate his equipment or furnish the next larger size. This is certainly no change from standard practice.

Some very-high-gain transistor equipment is subject to a second type of temperature problem; that of temperature variation. As pointed out, transistor characteristics may vary considerably with temperature changes. These variations are normally factored into the circuit design, or if required, constant temperature ovens or other devices are used. The designer will, however, for economic reasons, assume certain average variations. If your equipment will be placed outdoors, or in an unheated room or perhaps in front of a furnace door which opens periodically, by all means inform your supplier, who will then decide what modifications are needed.

Power supply variation is a third factor to consider. Modern power systems hold frequency close enough so that very few problems will be encountered. Voltage variation is another matter. Where the transistor is used as a simple on-off switch, reasonable variations are of little consequence, but in a high-gain multistage amplifier, such as might be used on a paper-machine speed regulator, it's very important. Again, the designer will factor in certain assumptions (usually ± 10%), but unusual (*Continued on page* 200)

The 4500-psi standard for valves proposed in December *Power* aroused much interest and discussion. Comments from engineers reveal almost complete agreement on the need for a new standard. But the question of what pressure level to use is not wholly resolved. In the concluding article of this series the author gives further reply to last month's comments on . . .

Now, a 4500-psi standard for valves?

By W F CRAWFORD, President, Edward Valves Inc, subsidiary of Rockwell Mfg Co

The great interest shown in the recommendation that industry adopt a new pressure class at 4500 psi . . . is very gratifying. Whether or not a new design plateau should be established doesn't seem to be any issue. The question that is not wholly resolved by all is the question of the level at which the next standard should be set for maximum economic benefit to user and builder in the power, chemical, hydraulic, petroleum and other industries.

We said in December that "the time may come when industry will look back on this move as being too conservative." Why might the jump to 4500 psi be "too conservative"? Two reasons stand out. First, the pressure range of 3000 to 4500 psi . . . is characterized by great sensitivity to temperature. Even the common range of boiler load swings, say 50 deg at 1050 F, will swing corresponding pressure ratings as much as 1000 psi in chrome-moly materials. So there is the prospect that anything less than 4500 psi as the next plateau will prove too timid even now!

Past history itself is the second reason. Too many pressure classifications have already been established. And this rash of pressure classes still burdens industry with the development and tooling costs that were written into production costs in the expectation of long and useful life. But look how the 400- and 900-psi classes were left behind so quickly. The user has paid far more for the timidity of those standards than he would have paid had they been bolder.

Experience shows that the active life of most pioneering standards is very short. By the time a proposed standard has been talked about, thrashed out by committee after committee, and finally ratified by the industry . . . we find that technology has advanced the frontier. So, many new standards have been obsolete on the day of final dedication.

This is not the first attempt to take a bolder step forward. Twenty years ago, another valve manufacturer developed a 4000-psi standard. It was a commendable proposal but was not adopted by many industries, particularly power, simply because the connections involved were not suitable for the combination of pressure and temperature. In 1939 this manufacturer published several interesting articles. He said:

"Subcommittee 3 of ASA Sectional Committee B16 was organized to take up this subject. Frequent meetings of this Subcommittee were held during the years 1923 to 1926 and in April 1926 the first proposed draft of a standard for steel pipe flanges and flanged fittings was completed. It was approved . . . in 1927. . . .

"This 1927 Standard included flange and flange-fitting dimensions for the pressure classes of 250, 400, 600, 900 and 1350 pounds at a temperature of 750 F . . .

"In spite of the general satisfaction given by the 1927 Standard, it had not long been in use when revisions and expansion were found desirable."

So the 1350-psi standard, almost immediately after its approval, was obsolete. Again, in the Thirties and Forties approved standards soon required further modification because they were too conservative.

Yet many suggest the industry is not ready to live in a 4500-psi era, even though B16 Subcommittee 3 agreed on the 4500-psi level as far back as October 1956. If we now say that we should consolidate our gains before going much beyond 3000 psi, are we not slowing alvve and piping availability for the pioneer of the near future?

Some engineers comment that progress can be made by merely "beefing up" the 2500-psi designs. How long to beef up and beef up and beef up some more? Beefing up in itself is irrational. It costs more than standardization. We must keep in mind the overall aim, production at maximum economy.

Lack of standard pipe schedules above Schedule 160 is another obstacle that can be overcome. For example, parallel lines avoid unwieldy wall thickness. A new valve standard can be developed in spite of the wide range in pipe sizes used. We explained how to select a series of valve inside diameters to give fairly uniform changes in pressure loss from size to size. (*Continued on page* 190)

Perforated for your filing ease

Power's data sheet

No 307

Seamless carbon-steel pipe to ASTM Spec A-53 Grade B and Spec A-106 Grade B

Pipe Size In.	Nom. OD In.	Wall Thick In.	Temperature — F: To 650	700	750	775
			Maximum Allowable Stress — PSI: 15,000	14,350	12,950	11,875
Schedule 10						
14	14	.250	330	316	285	264
16	16	.250	291	273	246	230
18	18	.250	255	244	220	204
20	20	.250	233	222	201	184
24	24	.250	195	186	168	154
Schedule 20						
8	8.625	.250	540	517	466	430
10	10.75	.250	435	416	375	344
12	12.75	.250	366	350	316	290
14	14	.312	450	431	388	357
16	16	.312	390	373	336	312
18	18	.312	345	330	298	277
20	20	.375	399	387	349	316
24	24	.375	330	316	285	262
Schedule 30						
8	8.625	.277	630	603	544	495
10	10.75	.307	578	552	499	457
12	12.75	.330	534	511	466	423
14	14	.375	570	545	491	452
16	16	.375	495	474	427	395
18	18	.438	540	517	466	424
20	20	.500	570	545	491	450
24	24	.562	540	517	466	429
Schedule 40						
½	.84	.109	1695	1621	1463	1341
¾	1.05	.113	1455	1391	1256	1148
1	1.315	.133	1569	1501	1360	1242
1¼	1.66	.14	1059	1013	919	838
1½	1.90	.145	1005	961	868	796
2	2.375	.154	906	867	782	717
2½	2.875	.203	1215	1162	1049	963
3	3.50	.216	1095	1047	945	866
4	4.50	.237	975	932	841	770
5	5.563	.258	885	846	764	704
6	6.625	.28	833	796	719	659
8	8.625	.322	771	738	661	610
10	10.75	.365	720	689	622	572
12	12.75	.406	690	660	596	550
14	14	.438	690	660	596	547
16	16	.50	713	682	615	564
18	18	.562	726	695	622	575
20	20	.593	690	660	596	549
24	24	.687	683	653	589	540
Schedule 60						
8	8.625	.406	1035	990	893	821
10	10.75	.50	1071	1025	925	848
12	12.75	.562	1035	990	893	817
14	14	.593	999	961	862	791
16	16	.656	980	937	846	775
18	18	.750	1011	967	868	800
20	20	.812	990	947	855	786
24	24	.968	1005	961	868	794
Schedule 80						
½	.84	.147	3036	2904	2621	2404
¾	1.05	.154	2589	2482	2240	2050
1	1.315	.179	2612	2498	2255	2067
1¼	1.66	.191	1935	1851	1670	1535
1½	1.90	.20	1821	1742	1572	1442
2	2.375	.218	1665	1593	1437	1316
2½	2.875	.276	1943	1858	1677	1538
3	3.50	.30	1770	1693	1528	1400
4	4.50	.337	1599	1535	1385	1266
5	5.563	.375	1470	1406	1269	1167
6	6.625	.432	1470	1406	1269	1166
8	8.625	.50	1344	1286	1160	1064
10	10.75	.593	1311	1254	1132	1038
12	12.75	.687	1305	1248	1126	1033
14	14	.75	1311	1254	1132	1038
16	16	.843	1305	1248	1126	1034
18	18	.937	1305	1248	1126	1031
20	20	1.031	1299	1248	1126	1028
24	24	1.218	1290	1234	1113	1025

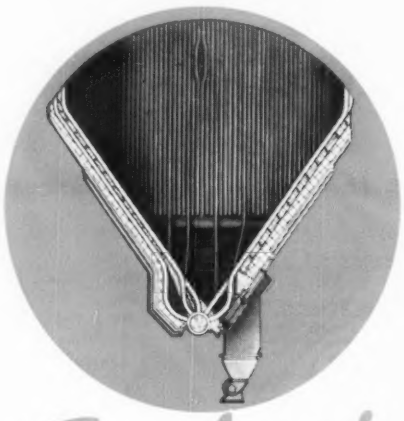
Pipe Size In.	Nom. OD In.	Wall Thick In.	Temperature — F: To 650	700	750	775
			Maximum Allowable Stress — PSI: 15,000	14,350	12,950	11,875
Schedule 100						
8	8.625	.593	1650	1578	1425	1305
10	10.75	.718	1635	1564	1411	1298
12	12.75	.843	1650	1578	1425	1309
14	14	.937	1695	1621	1463	1338
16	16	1.031	1635	1564	1411	1297
18	18	1.156	1650	1578	1425	1304
20	20	1.281	1650	1578	1425	1310
24	24	1.531	1665	1593	1437	1318
XX						
½	.84	.294	9222	8822	7962	7301
¾	1.05	.308	7532	7205	6502	5962
1	1.315	.358	7140	6831	6164	5653
1¼	1.66	.382	5580	5338	4817	4418
1½	1.90	.400	5115	4893	4416	4049
2	2.375	.436	4485	4291	3872	3551
2½	2.875	.552	4935	4721	4261	3907
3	3.5	.600	4410	4219	3807	3491
4	4.50	.674	3855	3688	3328	3052
5	5.563	.750	3480	3329	3004	2755
6	6.625	.864	3420	3272	2953	2708
8	8.625	.875	2609	2495	2252	2065
Schedule 120						
4	4.50	.438	2235	2138	1930	1773
5	5.563	.50	2130	2038	1839	1863
6	6.625	.562	2040	1951	1761	1614
8	8.625	.718	2070	1980	1787	1635
10	10.75	.843	1980	1894	1709	1565
12	12.75	1.00	2010	1923	1735	1590
14	14	1.093	2010	1923	1735	1592
16	16	1.218	1980	1894	1709	1564
18	18	1.375	1995	1909	1722	1582
20	20	1.50	1965	1880	1695	1558
24	24	1.812	2003	1916	1729	1585
Schedule 140						
8	8.625	.812	2385	2281	2059	1889
10	10.75	1.00	2406	2302	2077	1905
12	12.75	1.125	2295	2195	1981	1817
14	14	1.25	2340	2239	2020	1855
16	16	1.438	2376	2273	2046	1881
18	18	1.562	2304	2204	1994	1824
20	20	1.75	2340	2239	2020	1849
24	24	2.062	2310	2210	1994	1826
Schedule 160						
½	.84	.187	4545	4348	3923	3602
¾	1.05	.218	4500	4305	3885	3565
1	1.315	.25	4296	4110	3709	3401
1¼	1.66	.25	3006	2876	2590	2380
1½	1.90	.281	3090	2956	2668	2450
2	2.375	.343	3225	3085	2784	2553
2½	2.875	.375	2961	2833	2556	2344
3	3.50	.438	2930	2803	2529	2319
4	4.50	.531	2865	2740	2473	2273
5	5.563	.625	2790	2669	2409	2211
6	6.625	.718	2730	2611	2357	2165
8	8.625	.906	2715	2597	2344	2149
10	10.75	1.125	2753	2633	2376	2179
12	12.75	1.312	2730	2611	2357	2165
14	14	1.406	2670	2554	2305	2117
16	16	1.593	2670	2554	2305	2113
18	18	1.781	2670	2554	2305	2110
20	20	1.968	2663	2547	2299	2108
24	24	2.343	2655	2540	2292	2103

Maximum allowable working pressures — 2

Figures in table give maximum psi pressures for given temperatures and stresses. Don't exceed 600 psi for A-53 seamless piping. See February *Data Sheet* 306 for basic formula from which table was calculated.

GEORGE C HALZELL, *Boston, Mass.*

© POWER



...another The *Exclusive* Single

Saves Space

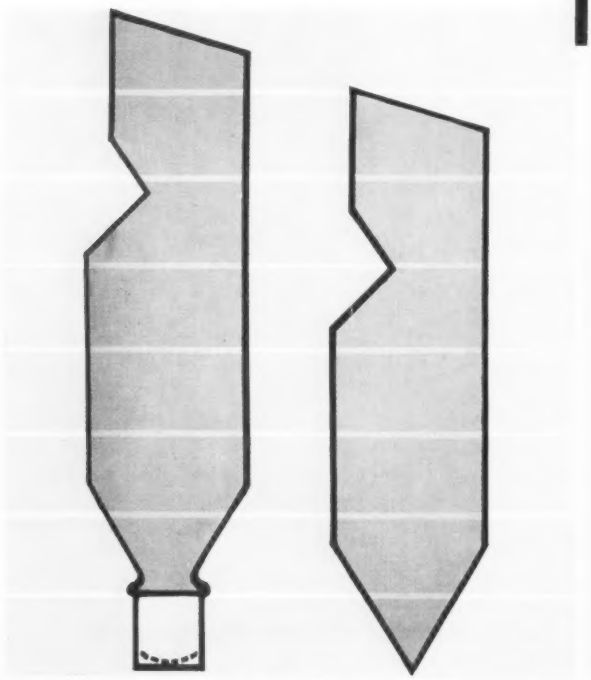
Reduces overall height of structure. Permits higher capacity in restricted area.

Adaptable to

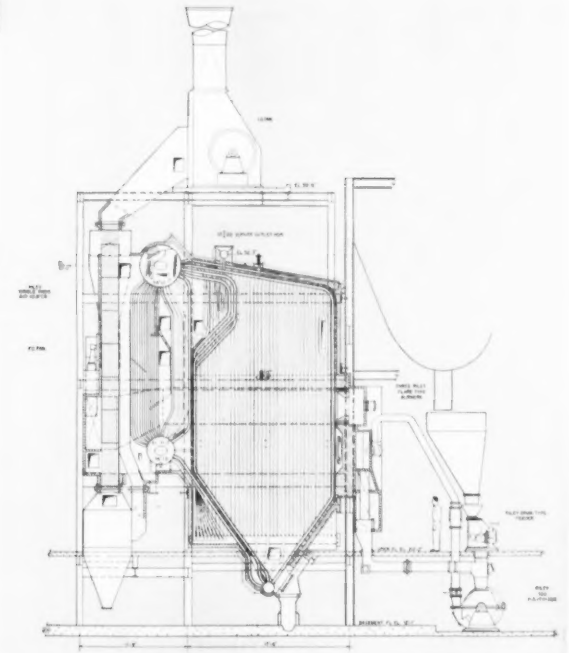
High capacity central station type units

and to

Small industrial type units



Unit with hopper added. Single Header Hopper Unit.

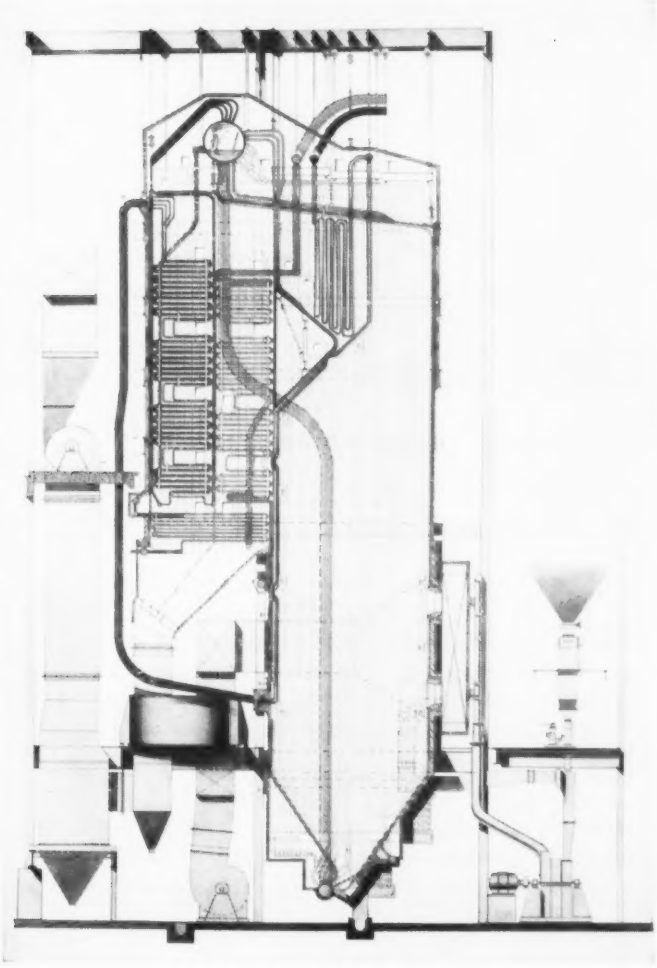


A 60,000 lbs/hr industrial type unit with Single Header Hopper

A survey of your plant by qualified consulting engineers could show ways of making surprising savings in your power costs.

money saving RILEY design feature

Header Hopper Bottom



A large Riley public utility reheat unit with Single Header Hopper

The Riley Single Header Hopper is so called because the furnace wall tubes are used as the sloping sides of the hopper and connect to a single header at the bottom. This simple arrangement eliminates the space required to install a separate ash hopper, thus reducing the overall height of the unit and permitting a unit of higher capacity to be installed where head room is a limiting factor. Additional savings are realized in the elimination of hopper seals and their maintenance.

Riley units with Single Header Hopper Bottoms are especially suited to multiple fuel firing and are extremely successful with coals of low ash fusion temperature. If installed initially to burn either coal or gas, coal can be burned at any time; a simple hydraulic or pneumatic ash removal system can then be added.

Riley Single Header Hopper Bottom Units are furnished in any steam capacity, temperature and pressure.

It will pay you to investigate further the economies possible in this exclusive Riley design feature.

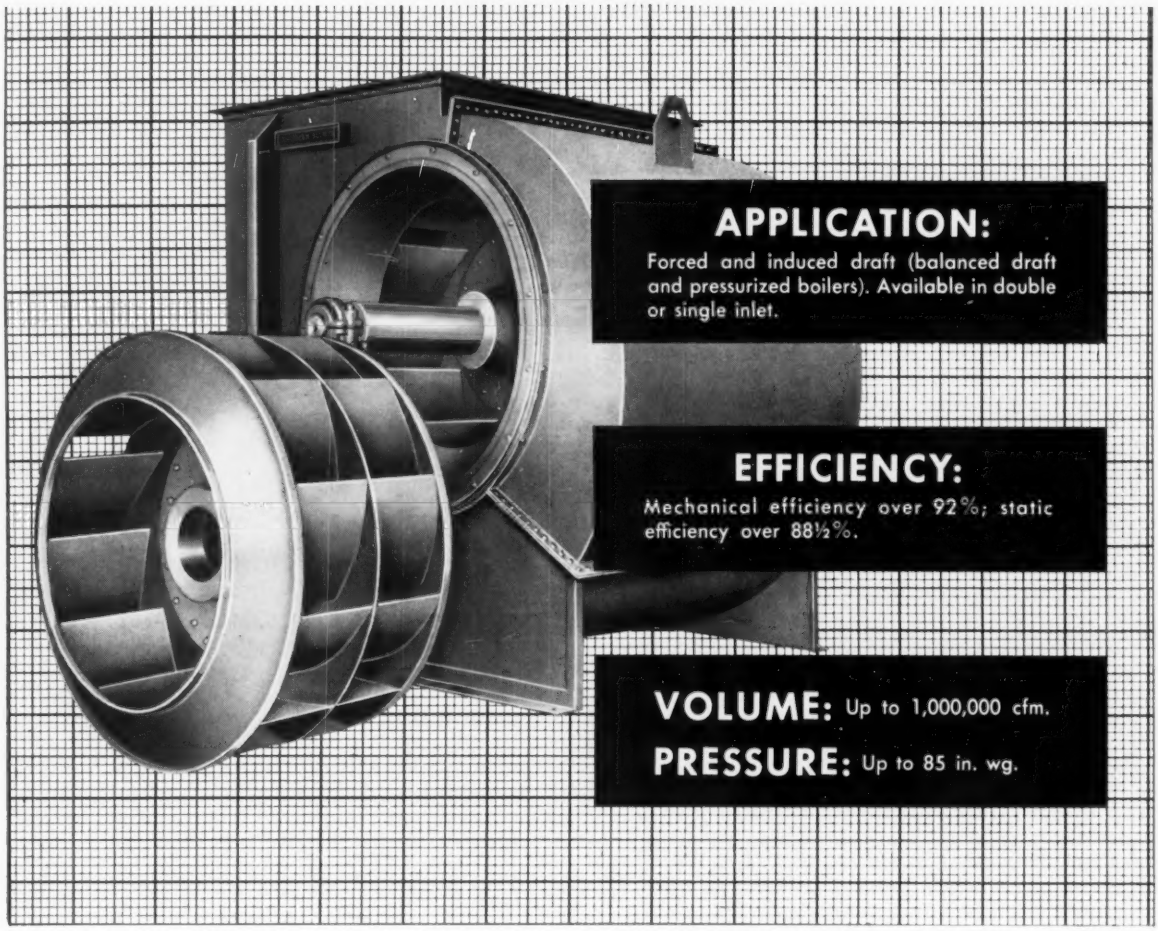
RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

Riley Stoker Corporation, Worcester, Mass.

Atlanta, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Worcester.

AMERICAN BLOWER AIRFOIL FANS


APPLICATION:
Forced and induced draft (balanced draft and pressurized boilers). Available in double or single inlet.
EFFICIENCY:
Mechanical efficiency over 92%; static efficiency over 88½%.
VOLUME: Up to 1,000,000 cfm.
PRESSURE: Up to 85 in. wg.

If you're thinking "airfoil" on your next mechanical-draft installation, think of American Blower.

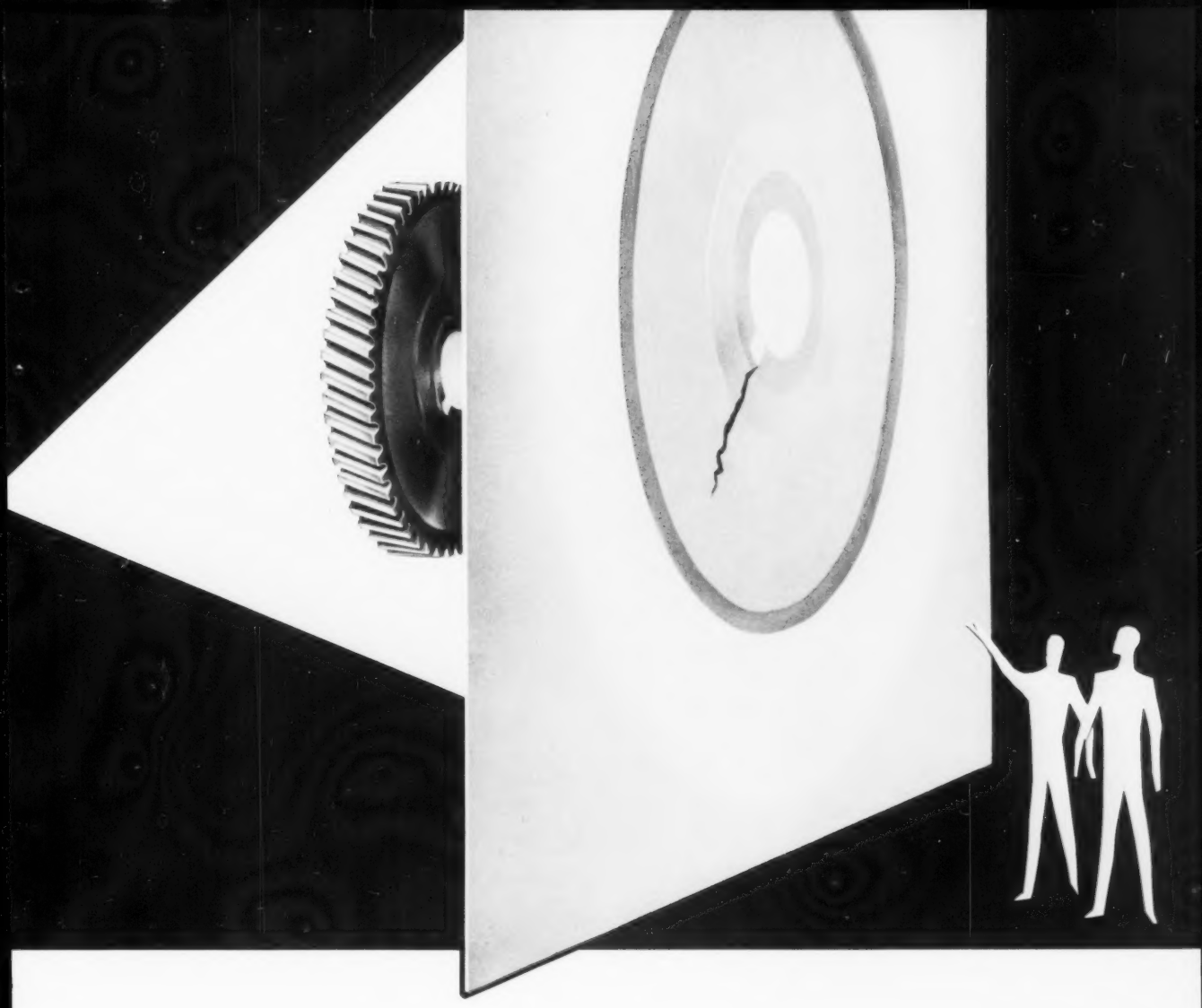
For, the advanced design of American Blower Airfoil Fans provides a smooth interworking of properly designed housing, streamline inlets, and wheel component parts – which results in higher efficiency, lower power consumption. The nonoverloading horsepower characteristic makes it possible to select a driving motor close to the fan horsepower.

Team this fan with American Blower *Gyrol*® Fluid Drive and you have a unit which gives high efficiency with low operating cost – plus quieter operation over the full operating range, and longer life of the critical fan parts. In addition, a motor with standard WR^2 capacity is all that is required, because of low starting inertia.

Why not talk to an American Blower sales engineer about *your* requirements. His knowledge of air-handling equipment can prove invaluable to you. Call our nearest branch office, or write: American-Standard,* American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION



First step to preventive maintenance . . .

Nondestructive testing

Today, preventive maintenance starts with nondestructive testing. It's the dynamic new philosophy that's fast making inroads across all industry. Why? Simply because no material is perfect. And you can't accurately predict machine life if you don't know the true condition of its internal parts. The testing cycle, as shaping up, starts with a check on materials supplied to the equipment builder; further tests during fabrication; followed by regular checks during machine's operating life.

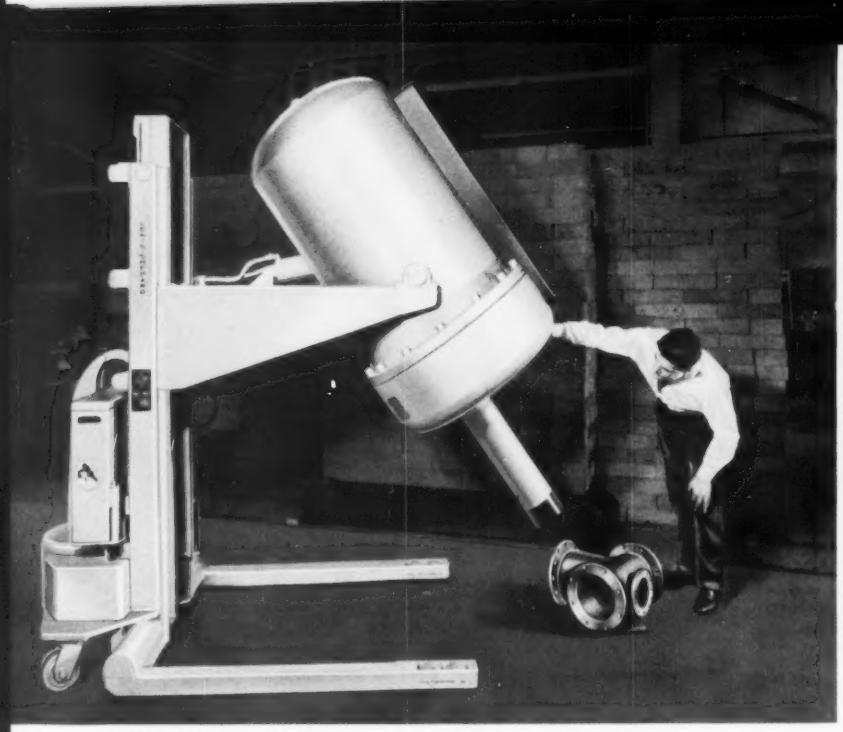
In brief, the purpose behind nondestructive testing of mechanical parts is simply to detect and evaluate any defects or predict the strength and serviceability of the parts. Flaws may be inherent within a material or they may arise during any stage of building the complete machine.

Over the years, aircraft manufacturers have been breaking technical ground in the use of nondestructive testing—and with good reason. For example, a serious flaw in a propeller blade can be disastrous. So blade testing often costs more than the blade—but it pays off.

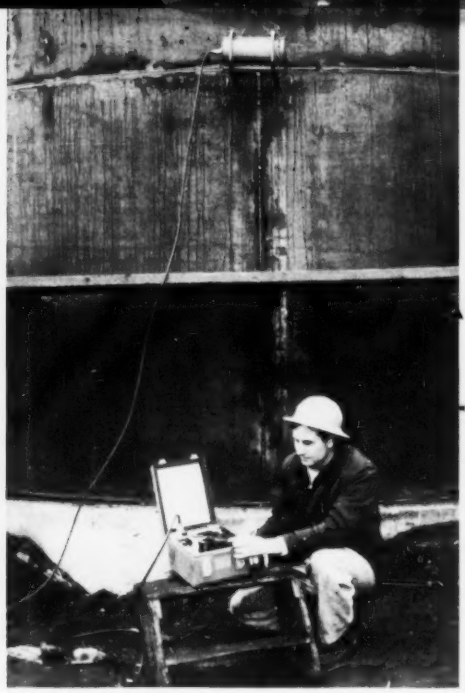
From the machine builder's angle, NDT means spotting faulty castings and forgings before the expensive machining and finishing is done. They also have assurance machine won't fail in service because of defective materials. From the machine user's side of the fence, NDT as a maintenance technique provides a degree of assurance between scheduled shutdown periods.

Following pages outline the tests available today, how they are used in manufacturing and maintenance.

By **STEVE ELONKA,** Associate Editor



MILLION-VOLT X-RAY UNIT finds hidden defects in metals. Fine focal spot and constant potential permit radiographs of exceptional clarity on fine grain film



PORTABLE UNIT X-rays welded seam during the construction of an oil-storage tank

X-ray is old standby; it finds flaws,

When we talk about radiographic inspection we include X-ray, gamma ray and variations of these methods. Basically, method involves passing rays through materials to be tested. Rays impinge on a film or screen, reveal and record the internal structure of test object.

X-rays have wave length ranging from 1/10,000 to 1/10,000,000 that of visible light. They are activated by transformers with capacities of a few thousand to several million volts. Shortness of the rays allows them to penetrate opaque materials. The number that penetrate a material depends on voltage applied to X-ray tube and current flowing through tube.

X-rays are produced when electrons traveling at high speed strike matter. In usual type of X-ray tube an incandescent filament supplies the electrons and forms the cathode, or tube's negative electrode. A high voltage applied to the tube drives electrons at high speed to the anode, or target. Sudden stopping of these rapidly moving electrons at or near the target's surface results in generation of X-rays.

Machines of 100 to 400 kilovolts are in general use, and portable units generating X-rays at 1000 to 2000 kilovolts are available. Size, weight and cost increase rapidly at higher voltages. Also, X-ray tube must support full voltage between cathode and anode.

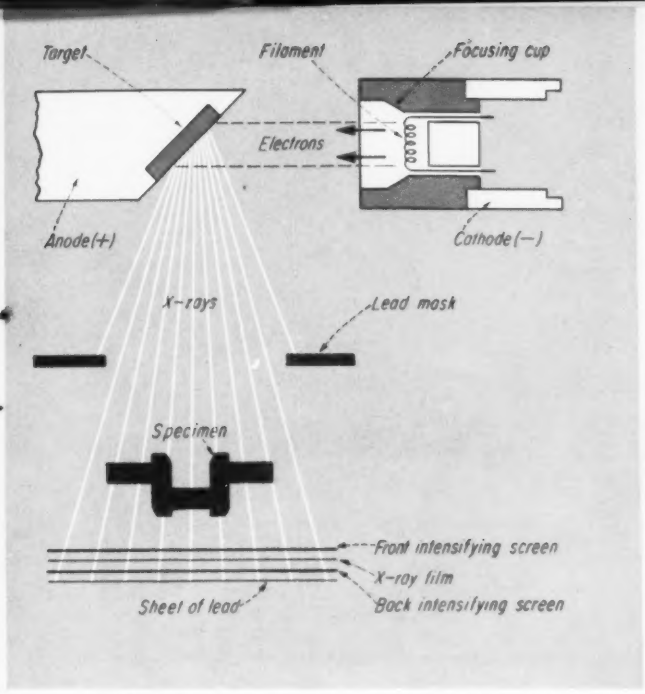
Two other sources of high-energy radiation are the induction electron accelerator or *betatron* and the linear accelerator. These sources don't use the correspondingly high voltages needed for accelerating the electrons. They carry the X-ray energy level to the tens-of-millions electron volts for both deeper and sharper pictures.

Betatron consists basically of a magnet and transformer to guide and accelerate electrons in a circular orbit to very high energies. Electrons of a few hundred volts acceleration per revolution are thus energized to many millions of electron volts before striking a target to produce X-rays.

Radiograph is a photographic record produced by X-rays or gamma rays passing through an object to a film. When film is exposed to X-rays, gamma rays or light, an invisible or latent change is produced in the film emulsion. Exposed areas become dark when film is immersed in a developing solution. Amount of darkening depends on degree of exposure. After developing, film is rinsed, preferably in a special bath to stop development. Next, film is put into a fixing bath which dissolves the undarkened portions of the sensitive salt. Then it's washed to remove the chemicals.

Diagram, above, shows essential features in exposure process. Focal spot is a small area in X-ray tube from which radiation emanates. In gamma radiography, it's the capsule containing the radioactive material, for example cobalt-60, which is the radiation source. In either case, radiation proceeds to the object in straight lines. Some rays pass through object, others are absorbed. Amount transmitted depends on energy of radiation, nature of material and its thickness.

If object is a steel casting having a void, for example, a void formed by a gas bubble, the void reduces total thickness of steel to be penetrated. So more radiation passes through section containing the void than through surrounding metal. Dark spot corresponding to projected



X-RAYS pass through the part to be radiographed, impinge on the film beneath the part and record many of the flaws

Typical X-ray machines and applications

Maximum voltage (kv-peak)	Screens	Applications and approximate practical thickness limits
50	None	Extremely thin metallic sections. Wood, plastics, biological specimens, etc
150	None or lead foil	Light alloys, 5-in. aluminum or equivalent; 1-in. steel, or equivalent
	Fluorescent	1½-in. steel, or equivalent
250	Lead foil	2-in. steel, or equivalent
	Fluorescent	3-in. steel, or equivalent
400	Lead foil	3-in. steel, or equivalent
	Fluorescent	4-in. steel, or equivalent
1000	Lead foil	5-in. steel, or equivalent
	Fluorescent	8-in. steel, or equivalent
2000	Lead foil	8-in. steel, or equivalent
15-24 mev*	Lead foil	16-in. steel, or equivalent
	Fluorescent	20-in. steel, or equivalent

*Million electron volts

leaves a record

position of void appears on film when developed. So a radiograph is a shadow picture: darker regions on film represent the more penetrable parts of object, lighter regions the more opaque.

X-ray and other photographic films are sensitive to direct action of X-rays, but photographic effect can be greatly increased and exposure time decreased by using an intensifying screen in contact with each side of film. This screen consists of a powdered fluorescent chemical. It's a calcium tungstate, mixed with a binder and coated on cardboard. Screen converts some X-ray energy into ordinary visible and near-visible light to which film is very sensitive.

Lead foil can be used as an intensifying screen. But foil's action is much less effective than fluorescent chemical in reducing exposure time. Its principle of operation is different. Under the excitation of X-rays or gamma rays of short wave length, it's a good emitter of electrons that exposes the sensitive film, thus increasing the total photographic effect. Type of screen you should use, if any, depends upon a number of things.

All materials not only absorb X-rays and gamma rays in varying degrees, but also (1) scatter rays in all directions and (2) modify and change the wave length of the radiation. In radiography, film receives scattered and modified radiation from the object, film holder and any other material in path of primary X-ray beam. Effect is to diminish contrast, apparent detail and clarity of radiographic image. Lead foil in contact with the film lessens relative effect of this longer-wave-length scattered radiation and, thus increases the radiographic contrast.

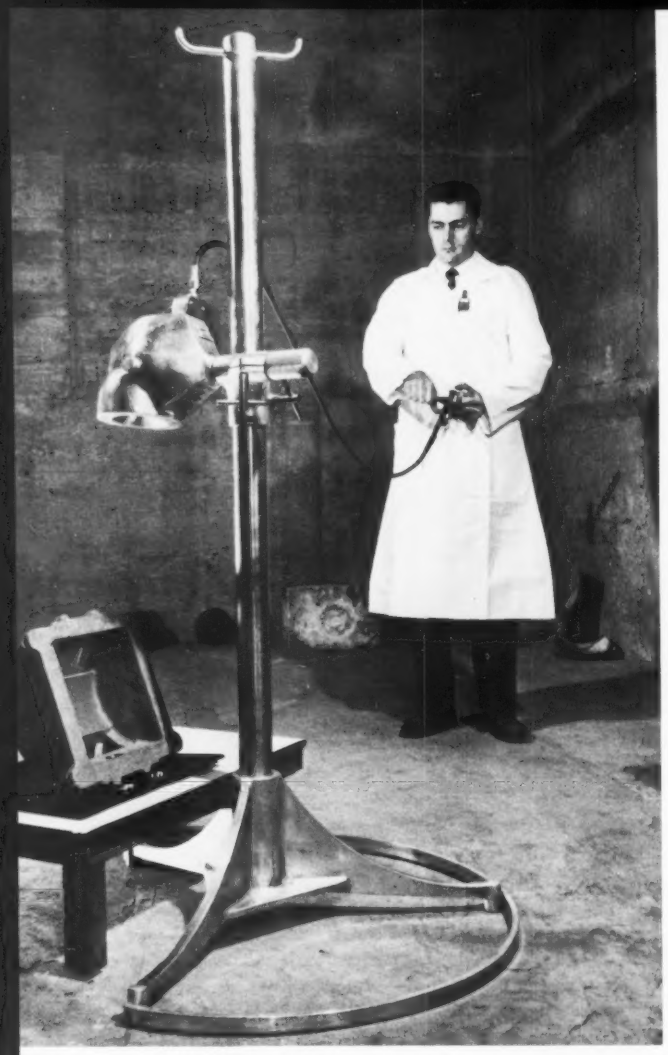
A filter of copper or lead is sometimes placed between the X-ray tube and object, or between object and film, to diminish effect of scattered radiation upon film. A lead mask that limits volume of matter exposed to primary radiation is also helpful in reducing scatter.

Several special types of X-ray film are used for radiography of materials. One type is for fluorescent intensifying screens. Some types work best with lead screens or without screens. Films come in various degrees of contrast and grain characteristics. X-ray films are commonly coated with emulsion on both sides of the support. Superposition of radiographic images of two emulsion layers doubles the density and greatly increases the speed.

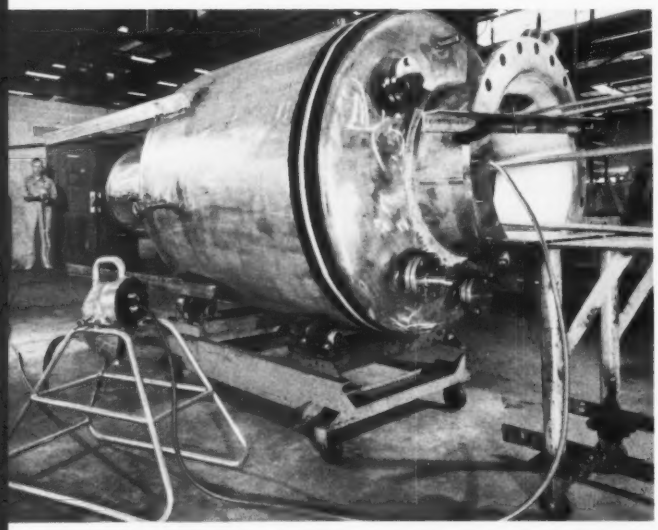
X-ray machines may be roughly classified according to their maximum voltage. Choice depends upon type of work to be done. Table, above, lists voltage ranges to typical X-ray machines and applications of each machine. These ranges are approximate since machine's exact voltage limits vary from one maker to another.

Fixed or mobile machines. Machines listed in table may be fixed or mobile, depending on design. When material to be radiographed is portable, X-ray machine is usually permanently set in a room protected against radiation escape. X-ray tube itself is often mounted on a stand or suspended from a bridge crane, allowing freedom of movement. For examining fixed or hard-to-move objects, use mobile X-ray machines. These may be truck mounted or small and light enough to carry on scaffolding or through manholes. Some are self-propelled to pass through pipelines.

Semiautomatic machines radiograph a large number of relatively small parts on a production-line basis. During exposure, operator may arrange the parts to be radiographed at the next exposure. Then, he can remove those just radiographed with an obvious saving in time.



BEAM OF IRIDIUM-192 is shot through 1-in. thick aluminum casting. Exposure time depends mostly on strength of the source



INTERNAL EXPOSURE of circumferential weld of 1-in. thick stainless-steel high-pressure vessel. Iridium-192 is the isotope used

GAMMA RAYS penetrate heavy metal, but no external source is needed since a tiny capsule does all the work

Isotope radiography:

Isotope radiography is now replacing or substituting for high-voltage X-ray in some applications.

Compared with X-ray equipment doing a comparable job, gamma-ray cameras need no power source, are light and require no maintenance during life of radioisotope. They are better for thick sections of metal, while X-ray is better for thin sections. Exposure time depends on source strength, not on amperage and voltage.

Exposures are short. Time depends on five factors: film speed, source, source strength, distance and thickness of material being radiographed. A slide rule helps to calculate each job's exposure quickly.

You don't need external power. When shutter is open, a radioactive isotope inside the projector sends out beams of gamma rays that produce shadow images on developing the exposed radiographic film. You can adjust beam's shape as a cone for spot shots on pipe welds, as a hemisphere or as a doughnut ring for making complete 360-deg panoramas inside large pressure vessels and tanks. Gamma-ray projectors come in various sizes.

Besides radium, pile-produced radioisotopes such as thulium, iridium, cesium and cobalt are used. Each of these emits radiation at a characteristic energy level. So you must select them on the basis of thickness and density of material to be gamma-graphed.

Gamma rays are similar in their characteristics to X-rays; they show the same similarities to and differences from visible light as do X-rays. They are distinguished from X-rays by their source, rather than by their nature. Gamma rays are emitted from the disintegrating nuclei of radioactive substances. Quality (wave length or penetration) and intensity of the radiation cannot be controlled by the user. Some gamma-ray emitting radioactive isotopes, such as radium, occur naturally. Other gamma-ray sources, such as cobalt-60, are produced artificially.

Radioactive materials used in industrial radiography

Radioactive element	Half-life	Energy of gamma rays (mev)	Gamma-ray dosage rate (roentgens* per hour per curie at 1 meter)
Radium	1620 years	0.24 to 2.20†	0.84
Cobalt-60	5.3 years	1.17 and 1.33	1.35
Cesium-137	37 years	0.66	0.39
Iridium-192	70 days	0.137 to 0.651‡	0.55
Thulium-170	127 days	0.084 and 0.054**	.....

* The roentgen is the quantity of x- or gamma radiation such that the associated corpuscular emission per 0.001293 gram of air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign.
† Eleven principal gamma rays.
‡ Twelve gamma rays.
** These gamma rays are accompanied by a more or less intense background of much harder radiation. The proportion of hard radiation depends upon the chemical nature and physical size of the source.

Industrial gamma-ray sources and their applications

Source	Applications and approximate practical thickness limits
Thulium-170	Plastics, wood, light alloys; ½-in. steel, or equivalent
Iridium-192	2½-in. steel, or equivalent
Cesium-137	3½-in. steel, or equivalent
Cobalt-60	7½-in. steel, or equivalent
Radium	5-in. steel, or equivalent

a practical substitute for the X-ray

Gamma-ray emitting isotope may be placed in an aluminum, stainless steel (magnetic or nonmagnetic) or brass capsule. Most capsules are cylindrical or hexagonal, others have special shapes.

Radium, oldest of the gamma-ray sources, has been in use for 25 years. Newer sources include cobalt-60, iridium-192 and cesium-137. Iridium has a short half-life value and requires frequent replacement. Cesium is relatively new commercially; its potential use has not been fully exploited.

Other isotopes in various stages of evaluation are cerium-144, thulium-170 and cesium-134. First two hold promise of fulfilling need for low-energy gamma sources; cesium-134 promises greater specific activity than cesium-137. Hundreds of radiographic sources are in use today.

Intensities and dimensions. Cobalt-60 sources in use range from 0.1 to 25 curies per source with 75% of them having strengths ranging from 0.5 to 2.5 curies. (A curie is that quantity of any radioactive nucleide in which the number of disintegrations per second is 3.700×10^{10}.) There are several sources of 20 to 50 curies. Most cobalt-60 sources are cylindrical, with dimensions of 1/8 x 1/8 in. to 1/8 x 1/4 in. High-strength sources have dimension close to 1/4 x 1/4 in.

Iridium-192 sources range from 3 to 50 curies per source with cylindrical dimensions close to 1/8 x 1/8 in. Cesium-137 sources coming into use range from 0.5 to 100 curies per source.

Films and screens. All types of industrial radiographic films are used, depending on quality of radiograph and other practical items. With moderate to strong sources available, use fine-grain high-contrast film. With trend to strong source, high-quality films are used without sacrificing exposure times.

Radiation quality of gamma-ray source is determined by nature of emitter which isn't variable at operator's will. Gamma rays from radium and cobalt-60 have relatively great penetrating power and can be used to radiograph steel sections as thick as 8 in. Radiations from other radioactive materials have lower energies. For example, iridium-192 emits radiations roughly equivalent to 600-kilovolt X-rays.

Gamma-ray sources gradually lose activity with time. Rate of decrease of activity depends on kind of radioactive material. For example, a radium source decreases to half its original intensity in about 1600 years; cobalt-60 source in about 5 years; iridium-192 in about 70 days. So except for radium, this decrease in emission necessitates more or less frequent revision of exposures and replacement of sources.

Lead screens of 0.005 to 0.020 in. thickness are commonly used. Where scatter is problem, 0.040-in. screens or combination of thin screens and lead filters outside the film holder are used. Cardboard and flexible-plastic film holders are common practice.

Source-handling devices. Source shields are either stationary or portable. Most apparatus is portable and provides for both panoramic and limited field (ported beam) coverage. Also, facility to extend a source by remote control, several feet or more into hard-to-get-at places is on market. Shields are usually steel-cladded lead.

Long-armed forceps or fish poles, with or without magnetic tips, are used for manually transferring source capsules. This is an important safety measure.

Safety and health. Users of radioactive isotopes are required by the U.S. Atomic Energy Commission to show competence and certain knowledge for proper handling before they can buy. Inspection tours are made by the Commission to see that rules are followed. Codes covering health and safety are also in force—follow them.

Fluoroscopy is fast, low cost, gives you story at a glance

LOOKING THROUGH METAL, this industrial fluoroscope enables you to study part while standing outside protective cabinet

Fluoroscopy meets the need for a fast, low cost internal inspection for items in quantity production. Fluoroscopy differs from radiography in that the X-ray image is viewed directly on a fluorescent screen rather than from a film record. Illustrations, above, show principles of industrial fluoroscopic units.

There are three major fluoroscopic techniques: conventional, high definition and high brightness. They differ as follows:

	Conventional	*High brightness*	*High definition*
Max range aluminum	1¼ in.	2 in.	2-3 in.
Penetrameter sensitivity	8-13%	6-11%	Approx 2%
Specimen location	Against screen	Against screen	⅓-⅔ TSD
Target-screen distance (TSD)	15-24 in.	5-12 in.	12-18 in.
X-ray tube	1.5-2.3mm	1.5-2.3mm	.3-1mm
X-ray equipment	Up to 150 kv	Up to 150 kv	Spec 150 kv
Fluoroscopic screen	Standard	Standard	High definition
Viewing window	Lead oxide	Lead silicate	Lead silicate
X-ray protection	Medium	Medium heavy	Heavy

Protective cabinets and work-handling equipment are required for all fluoroscopic techniques. For some jobs, you may have to replace the fluoroscopic screen with an image intensifier tube to get a brighter image. Image tube converts light energy from initial phosphor surface to electrons. These are accelerated and focused on a smaller screen, increasing brightness by 500 to 1000 times. This screen is viewed through an optical system which brings image up to actual size.

X-ray television systems have been used experimentally to replace the fluoroscopic screen. Reasonably good sensitivity (4 to 5%) is possible through use of very-high-quality optics, a good live scan and low noise circuitry for one system. Rudimentary images have been obtained by using crystal screens and cobalt-60 at very low radiation intensities. Another type uses a large X-ray-sensitive vidicon tube with its allied TV circuitry. Its best sensitivity is obtained around 1-in. steel.

You can see that the present field for fluoroscopy is rapid inspection of light metal parts to reduce cost of X-ray examination. Sensitivities approaching radiography can be achieved. With use of higher-voltage X-ray units and image intensifiers, thicker and heavier materials can be examined internally at low cost. Developments now under way may increase the industrial application of fluoroscopy.

Brighter images. Part of the viewing problem is the relatively low-brightness level of images. Unlike medical uses, industrial applications are not limited to low X-ray intensity levels. One solution is use of X-ray tubes that produce a high-intensity beam which, in turn, produces a brighter image on the screen. Such tubes are being developed. A second solution is use of an image intensifier on the tough-to-get-through objects. Commercially available screens light output peaks at approximately 120 kv-peak, limiting their use for thick parts.

Experiments are going on with large optically clear sodium-iodide crystals, thallium-activated and other crystals to overcome this limitation. At low kilovoltage levels, image volume is a thin plane at the surface. At higher levels, image attains greater depth and permits definition at 2 mev of 0.5mm holes at 35% contact using photofluorography. Future use of electroluminescent screens, such as those being developed for TV, provide interesting possibilities. Higher-definition screens have been produced experimentally.

Photofluorography. Photography of the fluorescent screen has been used since the earliest days of X-ray experiments. Quality of lenses and screens have been im-

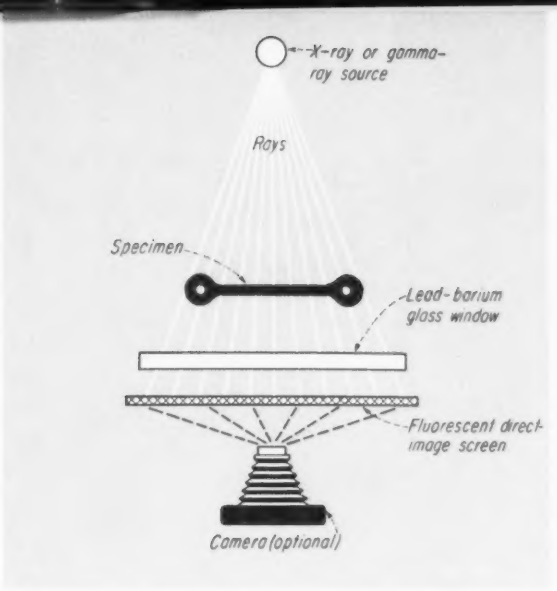
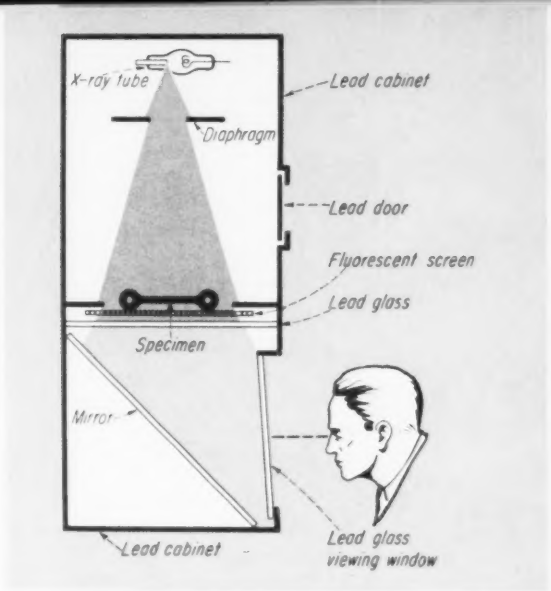


IMAGE TUBE converts light energy from initial phosphor-surface to the electrons that are focused onto the fluorescent screen



SCHEMATIC DIAGRAM shows an industrial fluoroscope. For more rapid examinations, material conveyors are usually installed

proved to where they are used routinely in medical-survey work. This technique, while not used widely in industry, has great possibilities for production inspection systems.

A solution has to be found for the problem of "burned-in" screen image that occurs during long exposures and shows on subsequent exposures. Film used can be 16, 35 or 70mm with 70mm preferred. Camera systems are rated focal spot 0.53 or better. Improved high-speed, high-contrast high-resolution film emulsions save film and also cut exposure time. Of course, high-quality cameras increase the capital cost of an inspection installation.

Use of fluoroscopy is spreading in many industries. Here are some present applications:

Electrical. Fluoroscopy is used to check (1) cables for core placement, wire continuity and protective-covering thickness (2) potted or canned components, coated or molded metal and plastic parts (3) high- and low-voltage fuses, timing mechanisms, resistors, capacitors. Insulators are also inspected for flaws, function or alignment. Experimentation has been done for soundness of wood products such as power poles.

Plastics. Flaws in casting, molding or extrusion of plastics can normally be demonstrated unless (1) flaws are extremely minute (2) section is quite large or (3) filler material varies considerably from the plastic material in density. All types of rubber products, including tires, are checked for faulty fabrics, alignment of molded-in parts and inclusions.

Foundry. Light-alloy castings are checked for gross flaws by conventional and high-brightness fluoroscopy, sometimes prior to radiography. High-definition techniques will replace radiography for certain types of castings. Heavy metal parts, up to 1½-in. steel or equivalent, are being examined experimentally.

Aircraft. Castings, some welds, plastics, wiring, electrical components and sandwich panels are all inspected by fluoroscopy. New construction methods may require whole sections of the final structure to be examined. Rocket powder up to many inches in diameter, small rocket assemblies, control components are fluoroscoped.

Food. Raw material for canned or frozen food packaging is viewed for undesirable inclusions before processing. Some final packaged products are fluoroscoped.

Initial cost of a fluoroscopic set-up may exceed that of a radiographic installation. This depends on complexity of work-handling equipment and degree of sensitivity required. However, you can get a fast, low-cost reasonably sensitive inspection. Because you can view the part from all directions when using fluoroscopy, the overall quality level may be equal to radiography.

Approximate radiographic equivalence factors of several metals

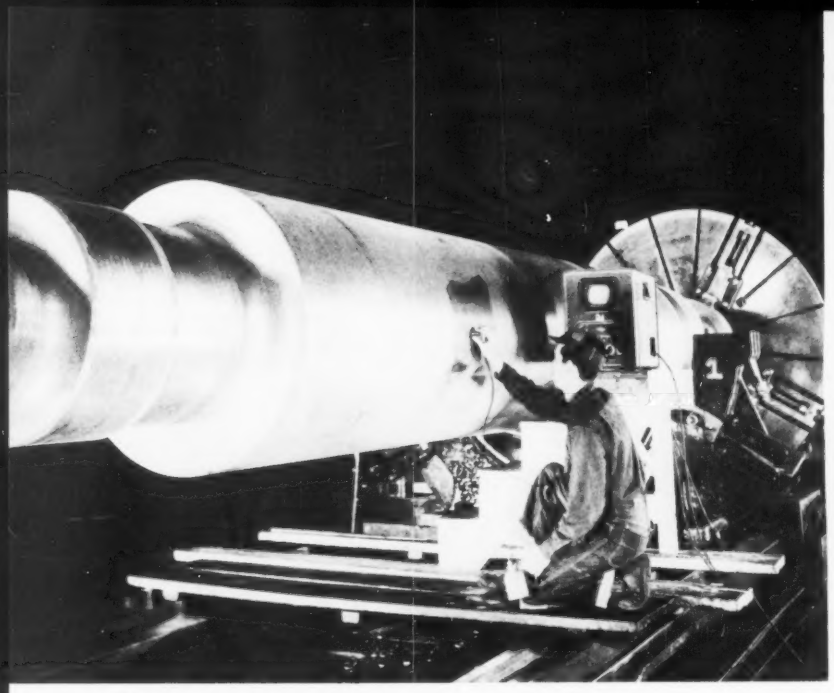
	X-rays								Gamma rays			
METAL	50 kv	100 kv	150 kv	220 kv	400 kv	1000 kv	2000 kv	15-24 mev	Iridium-192	Cesium-137	Cobalt-60	Radium
Magnesium	0.6	0.6	0.05	0.08								
Aluminum	1.0	1.0	0.12	0.18					0.35	0.35	0.35	0.40
2024 (aluminum) alloy	1.4	1.2	0.13	0.14					0.35	0.35	0.35	
Steel		12.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18-8 (steel) alloy		12.	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Copper		18.	1.6	1.4	1.4				1.1	1.1	1.1	1.1
Zinc			1.4	1.3	1.3				1.1	1.0	1.0	1.0
Brass*			1.4*	1.3*	1.3*	1.2*	1.2*		1.1*	1.1*	1.1*	1.1*
Lead			14.	12.		5.0	2.5		4.0	3.2	2.3	2.0

Aluminum is taken as the standard metal at 50 and 100 kv, and **steel** at the higher voltages and gamma rays. The thickness of another metal is multiplied by the corresponding factor to obtain the approximate equivalent thickness of the standard metal. The exposure applying to this thickness of the standard metal is used.

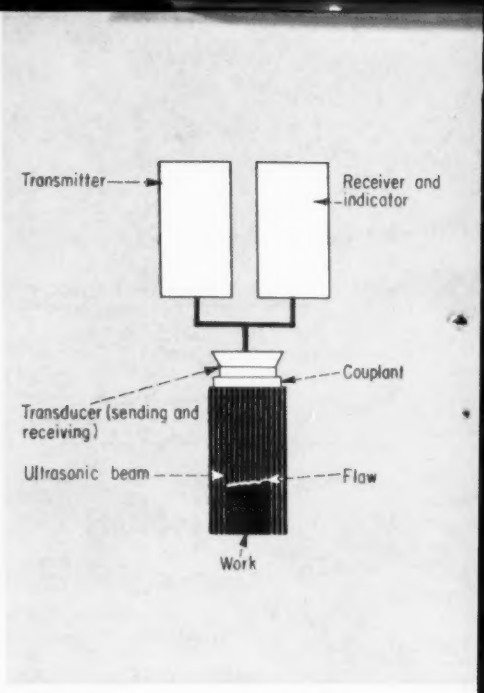
Example: To radiograph 0.5 inch of copper at 220 kv, multiply 0.5 inch by the factor 1.4, obtaining an equivalent thickness of 0.7 inch of steel. Therefore, give the exposure required for 0.7 inch of steel.

*Tin or lead alloyed in the brass will increase these factors.

Copyright, Eastman-Kodak Co



GENERATOR ROTOR FORGINGS are tested ultrasonically as they come from mill and before machining is finished. Mill makes test before shipping, so flaws are seldom found



PULSE ECHO bounces sound off flaw; either contact or immersed method is used

Ultrasonic testing is quick; there

Electronically produced sound waves have found many plant uses in recent years. These are distinguished from vibratory ultrasonic techniques (machining, cleaning, deburring and medical therapy) by a relatively weak sound that has no physiological effect on tissue.

Three methods are (1) pulse echo (2) through transmission (3) resonance. The first two methods are discussed below; see following pages for details on resonance.

Operation in each case depends on the fact that high-frequency sound behaves similar to audible sound. Frequency range in ultrasonics is roughly ¼ to 25 million cycles per second. These sound waves are transmitted through liquids and metals at the same speed as audible sound. *But they don't transmit well through air.*

The beam is reflected from a surface, just as an audible sound (an echo) or light. It can be bent (refracted) when passing from one medium to another in which sound speed is different, just as a light passing through a prism.

Ultrasonic-inspection equipment has a sound transmitter, a receiver, an amplifying system for the received signal, and a means of presenting this signal.

Basically this technique is akin to the sonar submarine-detector system where the signal bounces off a submerged object and returns. Ultrasonic flaw-detection equipment shows how thick the part is and if and where it has an internal flaw.

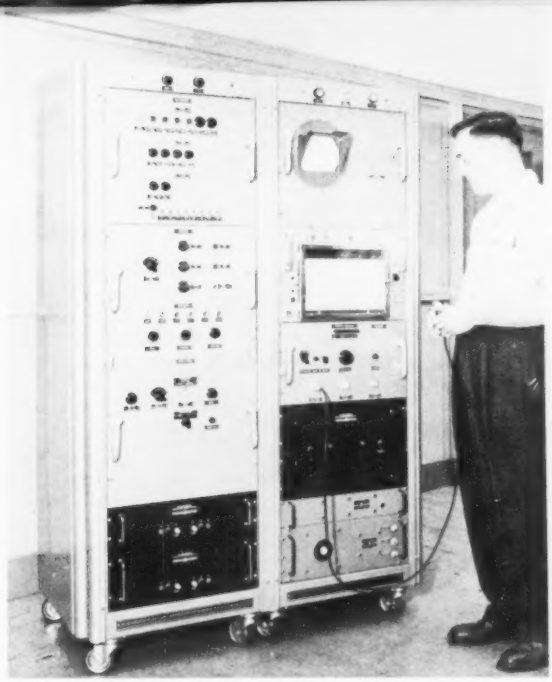
Pulse-echo system uses ultrasound as produced by "tickling" a thin crystal with rapidly alternating current. Crystals used have piezoelectric properties. They expand from current in one direction and contract when polarity is reversed, causing them to throb like a drum when ac is applied. Frequency of sound produced is determined by width-thickness ratio of crystal, rapidity with which current alternates. Piezoelectric crystal also produces electric current when subjected to pressure changes by a sound wave striking it.

Ultrasound is generated in short bursts or pulses. As high-frequency sound has almost no ability to travel through air, it's conducted to the part either through an oil film between the crystal and part (contact-inspection method) or through a column of water (immersed-inspection method) which varies from a fraction of an inch to several inches.

Upon striking surface, a large portion of sound reflects back toward the silent or listening crystal. Returning sound wave striking crystal is converted into minute electrical impulses as a pip or vertical line on the cathode-ray tube.

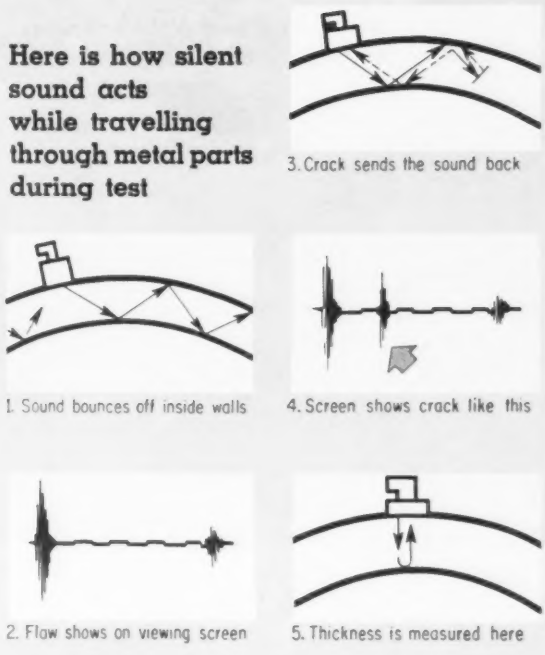
Portion of original sound front which struck the part but wasn't reflected, continues on into part to be partially reflected by next "interface," normally the opposite side of the part. Portion of this latter echo returns to crystal and lets out a second pip on the tube face. This pip will be farther to right on tube than pip representing echo from top of material.

This left-to-right progression of pips represents time-sequence travel of sound wave. Since sound speed is con-



AUTOMATIC INSPECTOR records pertinent data such as amplitude, depth and location for each indication it finds in part tested

Here is how silent sound acts while travelling through metal parts during test


3. Crack sends the sound back
1. Sound bounces off inside walls
4. Screen shows crack like this
2. Flaw shows on viewing screen
5. Thickness is measured here

are three methods

stant, this time sequence is translated into material thickness. Thus, space between these two pips represents total thickness of the material.

If there's a flaw at part's center, another pip will appear on the tube midway between the two that represents top and bottom (or "face" and "back echo") of the material. This latter pip is due to reflection of sound from the new "interface." With instrument set at high level of sensitivity, flaw can be about as small as a printed period and still register a readable pip.

Height of these flaw-indicating pips is significant since it's indicative of approximate area of a small (less than crystal diameter) flaw.

This evaluation of flaw size is found by comparing signal from natural-flaw indication with signal from flat-bottomed hole (an artifical flaw) at about same depth below material's surface in a test block of similar material.

These test blocks come in varying hole diameters, usually from $\frac{3}{64}$ to $\frac{1}{8}$ in., differing by $\frac{1}{64}$ in. increments. Set consists of a series of blocks of same material and hole diameter with hole depth below the surface varying from block to block.

Basis of standards of most industries which are concerned with comparatively small flaws is built around evaluation of flaw size. This depends on hole diameter in test block (of proper depth and like material) which gives a comparable signal height.

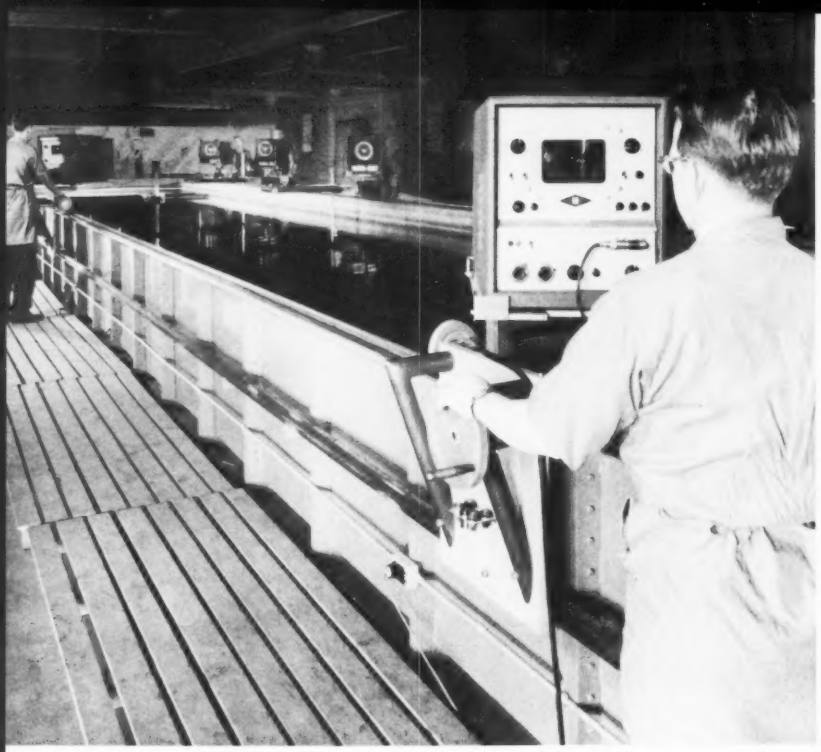
Through-transmission method is used in second type of ultrasonic equipment. This method is predecessor of pulse-echo system, yet is still useful. It often gives results where other methods can't be used.

Through transmission makes use of the same piezoelectric crystals as pulse-echo equipment. Basic difference is in use of *two* of these crystals: one transmits sound, other receives sound. Transmission may be intermittent bursts (as in pulse echo) or continuous.

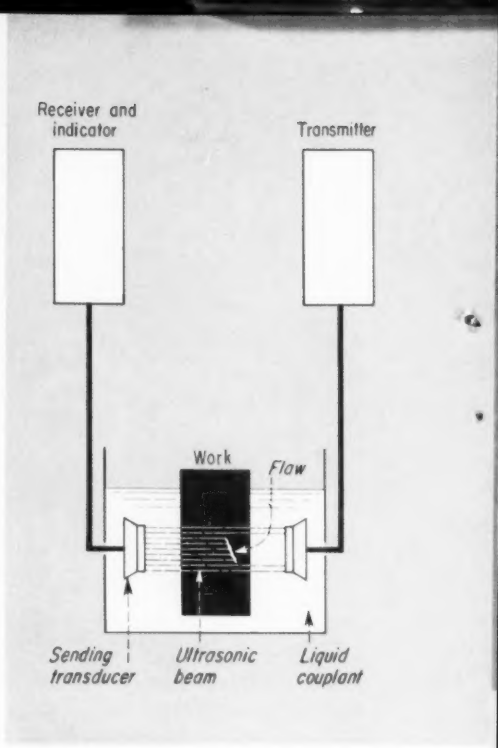
Crystals are coupled to part being inspected in the same way as in the pulse-echo technique: by an oil film or a water bath.

Once again signal from receiver is represented by pip on cathode-ray tube. But information given is somewhat different: like placing a flashlight on one side of a goldfish bowl and a light meter on the other. Reading for clear water would be about 100% transmission. But with silt (comparable to porosity in metal) or a fish (large flaw) transmission is accordingly reduced. This method doesn't give relative depthwise location of a flaw, but only its presence and magnitude. This is often enough information as defect's location may not be important.

Another advantage is greater penetrating ability (one-way trip for sound vs two-way for pulse echo). It works in materials that are too thin for pulse-echo work. Minimum thickness limitation is inherent in all ultrasonic systems which give "face" and "back echo" presentation. Now, turn page for details on the resonance method of ultrasonics, a most valuable test that is doing an outstanding job for many industries.



IMMERSION TANK with scanning instruments is long enough to submerge large structural parts for testing. These units are made for laboratory or for production quality control



COUPLING AGENT used in immersion method is a liquid. Water is most popular

Immersion test uses liquid couplant

In the immersion method of ultrasonic testing, both the part under test and the crystal are submerged in a couplant medium, usually water. Where the through-transmission technique is used, both crystals are submerged. Complete submersion of the part is unnecessary; only the zone between crystal face and material being tested need be immersed.

Since the liquid serves as a constant coupling between crystal and part, this method adapts itself well to the type of production met in aircraft, aircraft turbine and missile industries. Reason: fairly large part-runs are encountered, yet there is a demand for flexibility because of the many different type parts met.

Crystal assemblies used in immersion method are similar in principle to those of the contact type. Their difference lies in providing means for watertight connection of coaxial cable. Also, these crystals are designed for insertion in a tube or swivel socket. Latter provides a means for adjusting to a definite angle or for using in a manual adaptor for mechanically-holding rather than hand-holding as is case with contact crystals.

Beam coupling to material being tested takes place through water. So no plastic wedge is needed to get an infinitely variable beam entry angle. The crystal, itself, is available in many sizes and frequencies. Even the basic crystal composition is varied; this influences sensitivity and other characteristics. Sizewise, crystals range from a small $\frac{3}{4}$ in. diameter to a "paint-brush" mosaic piece several inches wide. Latter is suited to covering large areas in one pass with a considerable saving in time.

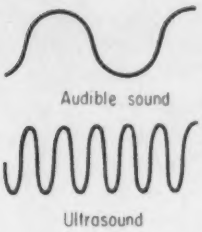
Advantages of the immersion method are many. First, look upon this technique as one well-suited for testing small and medium-sized parts. It's the method most widely used in the missile and aircraft industries for inspecting their complicated forgings and extrusions. Prime advantage lies in ability to infinitely vary angle of entry for the ultrasonic beam. This means interior of irregular sections can be searched at the optimum angle for each zone without changing crystal.

Another advantage of this flexible-angle feature lies in the ability of aligning the sound beam within the part so it impinges upon a defect at right angles (meaning a maximum return of the signal from defect to crystal). This boils down to greater accuracy in evaluating defect size when comparing results with the graduated test blocks already mentioned.

Sensitivity also plays an important role in evaluating the immersion method of ultrasonic testing. Actually, the immersed technique is less critical in the face of small bumps and hollows of varying radii. Material with such surface contours can be inspected without the difficulty which accompanies use of contact crystals.

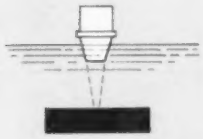
But maximum surface roughness, aside from the local contours which can be tolerated by either process, is about the same. This is usually considered to be between 250 and 150 RMS micro-in. But it is somewhat dependent upon the degree of sensitivity needed and the nature of the surface roughness which should be considered.

Here's how ultrasonics finds flaws



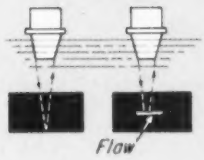
Ultrasound . . .

is any mechanical vibration of 18,000 or more cycles per second. For testing, transducer or search crystal is electrically excited for million cps or more



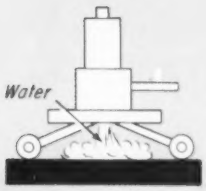
Immersion testing . . .

is ultrasound coupled with liquid to better penetrate most metals. Ultrasound in frequencies of 2.25 to 25 megacycles per second is usual for industrial products



Inspection data . . .

from echoes of inspecting frequency—from the material's front surface, rear surface, and interior flaws—are presented visually on a scope that's easy to read



Crystal dolly . . .

is used where immersion of material is difficult. Dolly has a stream of water between equipment and material, thus making immersion into a tank unnecessary

Immersed pulse-echo system was developed after World War II to meet the need for an effective means of finding internal defects in critical forgings for aircraft turbine-rotor and air-frame forgings. Internal flaws in a forged, rolled, extruded or, to use the general term, "wrought sections" are often tightly closed.

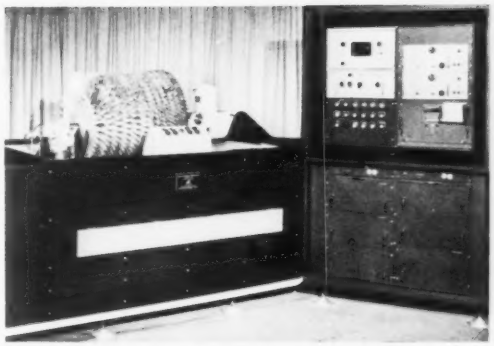
This condition is comparable to what would occur if a loaf of bread containing a few large bubbles were squashed flat. The more or less spherical bubbles in the loaf would become tight, flat disks.

Since X-ray inspection depends upon the variation in total thickness of the good areas vs the reduced mass where the bubbles displace the normal material, the X-ray would find these defects in their original spherical condition. But it would show no difference when bubbles had been flattened.

The ultrasonic method, however, uses these defects as "mirrors" or reflecting surfaces. They are most easily detected in the flattened condition, and it is in this condition that they are often present in wrought material.

For subsurface flaws which do not parallel the surface, as is often the case with forging bursts and some types of inclusions, there is usually some portion of the flaw face which is so oriented as to reflect sound back to the crystal. With the defect thus located, it's possible to vary the beam angle to give maximum signal to evaluate the size of the defect. This is another advantage.

Tanks today come equipped with precision manual manipulator, search tube and ultrasonic transducer.



Automatic inspection

Automatic ultrasonic inspection equipment for checking axial flow-rotors of jet engines, above, was first used for overhaul operations at an air-force base. Equipment can be used to make a full inspection in one hour, without dismantling the compressor rotor. This compares to about eight hours previously needed to perform a manual ultrasonic inspection.

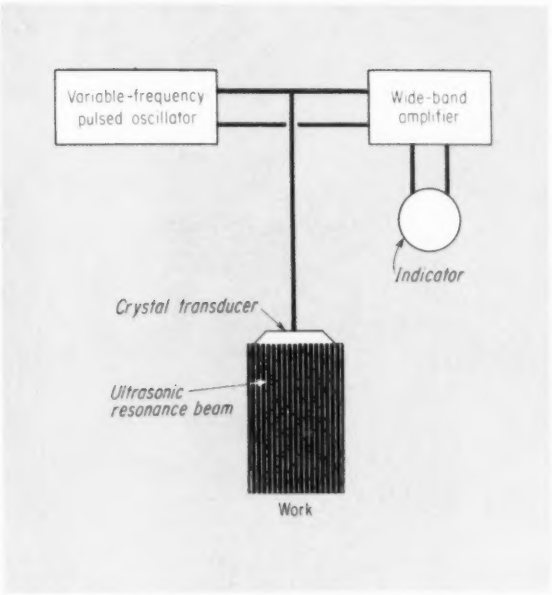
Equipment is designed to inspect rear-wheel lip of all rotor stages for cracks, and to record probe's location and signal during all phases of the inspection. It automatically scans each wheel and informs the operator when wheel inspection is completed. Unit can also detect a $\frac{1}{8}$-in. hole as close as 0.040 in. to the surface.

Ultrasonic frequencies can be 5, 10, 15, 20 or 25 megacycles, depending on material being inspected. Water is used as the coupling agent and only the section of rotor under test is immersed. A 17-in. cathode-ray tube gives a visual report of the inspection; a recorder pictures shape of any cracks.

Checking boiler tubes

Crystal dolly, above, is used to check boiler tubes for internal corrosion. Stream of water between the dolly and tube provides necessary transmitting medium where it isn't practical to immerse test material into a tank of water, as in fieldwork.

PORTABLE resonance unit can be used outdoors to check wall thickness of storage tanks, pipelines, etc. It's very simple to use



RESONANCE METHOD also uses piezoelectric crystal. Difference here is that frequency or 'tone' of sound is constantly varied

Resonance method measures thickness,

Resonance method is basically a thickness measuring system, but it's also well-adapted to finding laminar type flaws. Like the pulse-echo and through-transmission methods previously discussed, it uses a piezoelectric crystal that transmits and receives a high-frequency sound.

Method differs from others in that frequency or "tone" of sound is constantly varied, for instance, from 2 to 4 million cycles per second. This change is repeated many times per second.

Any piece of material has a natural frequency or resonance point to a sound wave beamed in the direction of its thickness. This point is a function of the thickness and the speed of sound in the material. Sound speed is independent of frequency and is almost constant for a given material, like 1020 steel or a particular aluminum alloy. Sound speed varies only slightly within a group of alloys, (for instance, in several of the aluminum alloys).

Crystal or *transducer* is placed against a part using an oil or other liquid film couplant, thus introducing a beam of ultrasound into the part. At some given moment, a frequency is transmitted whose wave length is an even multiple of thickness materials.

Transducer crystal reacts to this in-phase period to produce a pip (if material thickness is one-half the wave length) or series of pips (if material is a multiple of one-half the wave length) on the cathode-ray tube.

Location of pip or pips across the tube face is translated directly into thickness on a transparent chart superimposed on the face. This method is comparable to the way a musician might determine pitch of a tuning fork by striking successive notes on the keyboard of a piano. The tone that excites the tuning fork to ring corresponds to the fork's pitch.

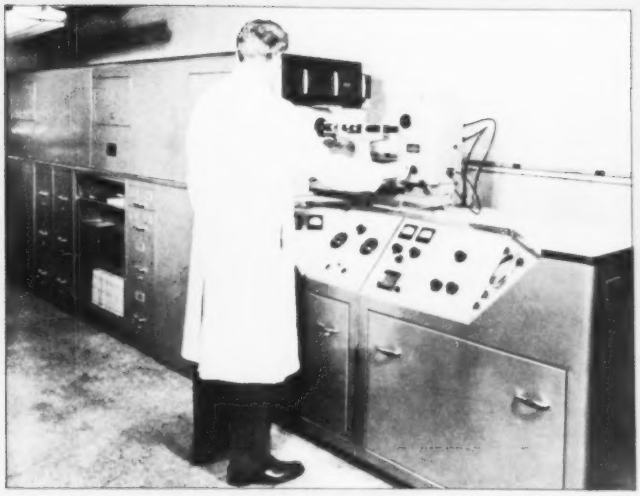
So far we've discussed three types of ultrasound and two types of couplings—*contact*, using liquid film; and *immersed*, in which part and crystal or crystals are submerged in liquid. All these tell us something about the interior of a piece of opaque material. Which is best? Why, how and where do we use them to advantage in industry?

Basic systems. As already outlined, the basic systems for you to consider are: (1) *pulse echo*, immersed and contact (2) *through transmission*, immersed and contact (3) *resonance*, contact only.

As usual, where several tools or methods have superficial sameness and some overlapping qualities, there's no *best* among them.

First, let's consider reasons for the two means of coupling sound to the part under inspection—immersed and contact. Coupling mediums usually used with these methods are water and oil. But water for immersed work is used mainly because it's cheapest and usually available. However, it can be replaced by petroleum oils or other liquids.

Contact inspection involves placing crystal against work surface—either directly, as with flat work, or by



Spectrograph

Units like this give you chemical analysis of high- and low-alloy steels, aluminum, copper, brass, zinc, lead, tin and newer metals like zirconium, titanium and uranium. It will analyze a sample of steel quantitatively for eight elements within a minute's time. It enables you to check materials before doing costly machining.

spots flaws

using an intermediary contoured shoe of plastic or metal where work surface has enough radius to prevent a good contact across major portion of the crystal.

Contact crystals consist of an actual piezoelectric wafer and a cylindrical or rectangular holding case with an integral connector for coupling a coaxial cable, which in turn, connects to an ultrasonic transmitter-receiver (called a scope). Crystal sizes vary: smallest resonance type crystals in common use have a ¼-in.-diameter active area and a housing of about ½ in. Smaller pulse-echo or through-transmission types have about a 1-in. OD. Larger sizes of 1½-in. diameter or greater, and rectangular shapes are also available for the three types of equipment.

A major advantage of contact inspection: it's the most portable system since you need only the scope, operator, crystal, an oilcan and standard comparison blocks. This method also provides greater power with respect to penetrating ability where crystal is directly coupled to part. For these reasons, contact method is used widely in railroad, heavy turbine, shipbuilding, etc.

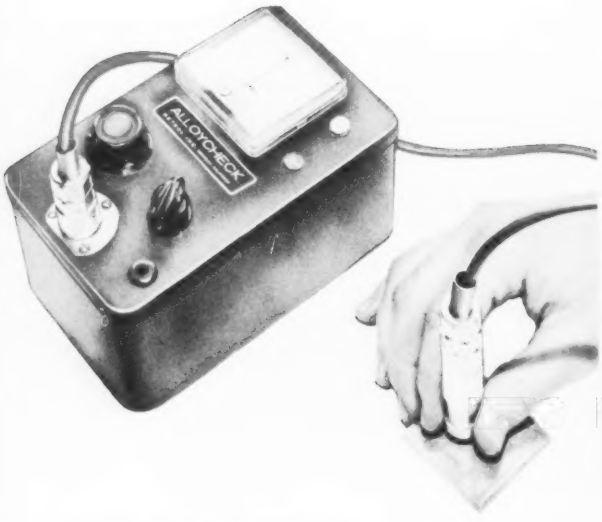
Because all internal flaws are not parallel to the surface from which an inspection can be made, and since contours of some parts prevent the search of what may be critical areas, a way had to be found to introduce the beam into the part at an angle to the surface. Plastic wedges, oil coupled or cemented to crystal face, proved the answer to this problem. Additional bending (refraction) of sound beam takes place where it enters material. Resultant beam angle is from two to four times as great as the angle of incidence. This permits search of otherwise inaccessible corners of a part because of billiard-shot effect, where sound bounces off surfaces within part, permitting greater flexibility.

Sound-beam direction in crystals is changed 90 deg, forming a wave which crawls along part's surface. Then it's reflected back to its source by such surface irregularities as cracks, scratches or sharp shoulders.

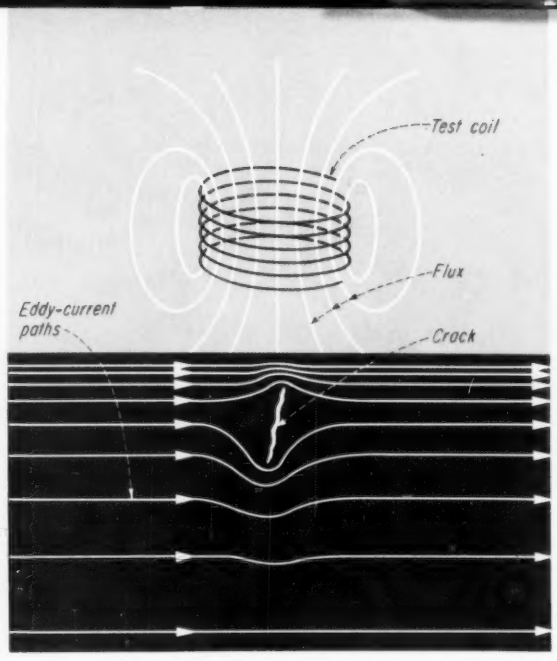
A major disadvantage of contact inspection: change of search angle requires a change of crystal. This often restricts it to incremental rather than infinite angulation. This method is also at a disadvantage where small random bumps and hollows are found (since crystal face must make reasonably good contact). However, these bumps and hollows can often be removed with a hand grinder or machine cut before inspection.

Uses. Ultrasonic inspection is applicable to a wide variety of materials. It permits you to "see" through almost all metals, the denser and more homogeneous plastics, even rubber. In general, metals that are good conductors of audible sound and that ring when struck (in a suitable section) are most easily penetrated by ultrasound.

The "dead" metals, such as lead and annealed copper, and the relatively coarse-grained materials, such as cast iron, are poorer conductors of ultrasound. The latter can be penetrated by extremely low frequencies which give poorer near-surface resolution. This applies to plastics and other nonmetallic materials, generally those which are dense and without porosity or fibrous fillers. In case of resonance testing, they increase the minimum thickness that can be measured. At extremely low frequencies, even concrete can be penetrated by ultrasound.



PORTABLE EDDY-CURRENT TESTER identifies alloys and their heat treatments. It is also used to check the material for strength



PATTERN OF EDDY-CURRENT is distorted by fault in a metal. Instrument gives alarm by either tone, lights, marker or other ways

Eddy-current testing can be either continuous or automatic

While eddy-current testing has been around for some 50 years, practical instruments to utilize the technique have been developed only within the last few years. Today, it's one of the promising testing methods.

Theory involved is simply that of magnetic induction: a magnetic field induces eddy currents within the material being tested. The magnitude and phase difference of these currents is, in turn, reflected in the actual impedance of the pickup coil. Careful measurement of this impedance is the revealing factor in detecting defects. Faults in the form of cracks, seams, laps, etc; changes in structure; chemical composition, hardness, conductivity, permeability; and size of test piece can all be determined through eddy-current tests.

Instruments available do their job of detection on a fully automatic high-speed basis. Parts may drop or pass through a coil, or a probe-coil can be moved over the surface of a part. In either case, basic principle is one of inducing eddy currents in the part's material and detecting the effect of these currents on a measuring coil or probe.

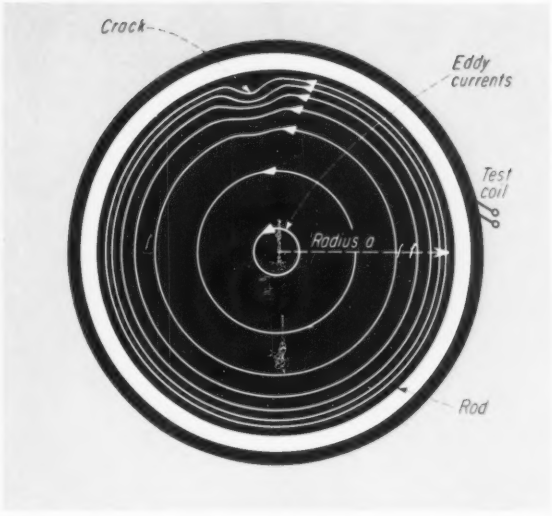
Method of bringing the part's material in proximity of the magnetic field, as outlined above, is simply a practical application of a well-known fact: eddy currents can be induced in metal by a wire-wound current-carrying coil with the coil surrounding the sample (test piece acts as core) or coil (probe) placed close to the sample. In either case, eddy currents are induced in the test sample in a direction opposing that of the magnetic field developed by the energizing current.

Frequency of test instrument, measured in cycles per second (cps), is an important factor. It may be as low as 5 cps or as high as several megacycles per second. Instruments available operate within these wide limits. Choice of an operating frequency for commercial equipment depends on many variables. Typical: conductivity, permeability, diameter or size of test piece. Also consider depth of penetration desired where maximum sensitivity is needed to detect defects or diameter changes. Signal-to-noise ratio is a top criterion in pinning down a specific frequency. Finally, factors such as character and physical location of defects plus speed of inspection all enter the frequency picture.

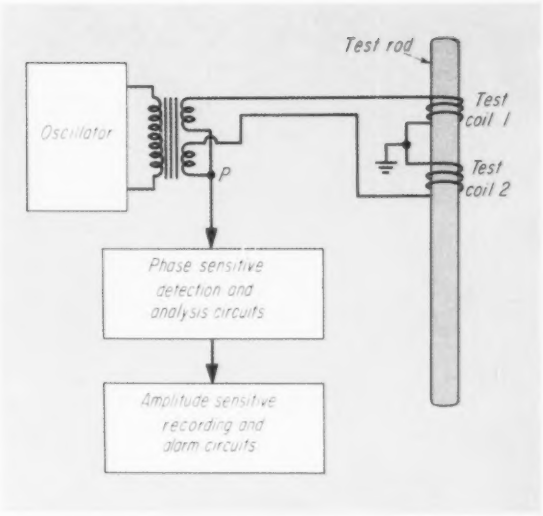
Analysis of test results boils down to probing an impedance pattern since impedance resulting from a coil held near a conductor is complicated by many variables. And some can be separated through a study of results. Changes that occur in the result-pattern involve differences in amplitude and phase plotted as impedance.

Coil design, hence frequency of current, must be varied. Electrical and geometrical properties of a coil also influence size of eddy currents as they concentrate near the specimen's surface. Current decreases below the surface of a plane conductor.

Various designs of test coils are available to (1) speed inspection of different shapes and sizes of material and



END VIEW OF ROD shows distribution of the eddy-current paths. The currents follow circular loops concentric with the rod



SCHEMATIC BLOCK DIAGRAM of an eddy-current test instrument. This hookup is used for flaw detection in tubing and bars

(2) allow increased sensitivity to defects or chemical and physical changes.

Balance coils (comparing test piece against a standard) are used to detect defects or changes in composition, heat treatment, etc. Difference coils (comparing one area to an adjacent area of the same piece) are used to detect defects independently from chemical or physical changes since latter's properties change gradually over the same piece.

Probe coils (or tangential pickup coils) permit point-by-point inspection for changes in physical or chemical properties, or for detection of defects.

Changes in electrical characteristics of test coil, produced by eddy currents, are usually detected with a bridge or comparator circuit. Information concerning the test piece can be presented graphically as a spot or curve on a cathode-ray tube, as a deflection of an indicating meter, or as a visible or audible alarm. Where many small pieces, or continuous lengths of bars, wires or tubes are inspected, auxiliary equipment can be added to permit automatic sorting or control of production machinery.

One instrument marketed is designed to measure absolute conductivity directly in percent of International Annealed Copper Standard (IACS). Standard conductivity has been defined by the International Electrotechnical Commission in terms of amount of resistance to be found in a specified grade of high-purity copper when measured at 20 C (68 F). This resistance amounts to about 0.15 ohms per gram meter, which has been arbitrarily designated as 100% conductivity.

Many nonferrous pure metals can be easily distinguished from one another by their conductivities. For example, pure lead has a conductivity of 8 to 9%. Gold ranges from 72 to 77%. Tungsten is in the range of 31 to 32%. Silver is about 102% IACS. Many nonferrous alloys have characteristic conductivities. This makes it possible to detect parts improperly heat treated and to unscramble mixed parts.

Unit is easily calibrated with known conductivity specimens supplied with instrument. Temperature of test material has little or no effect if calibration samples are allowed to stabilize to temperature of test samples.

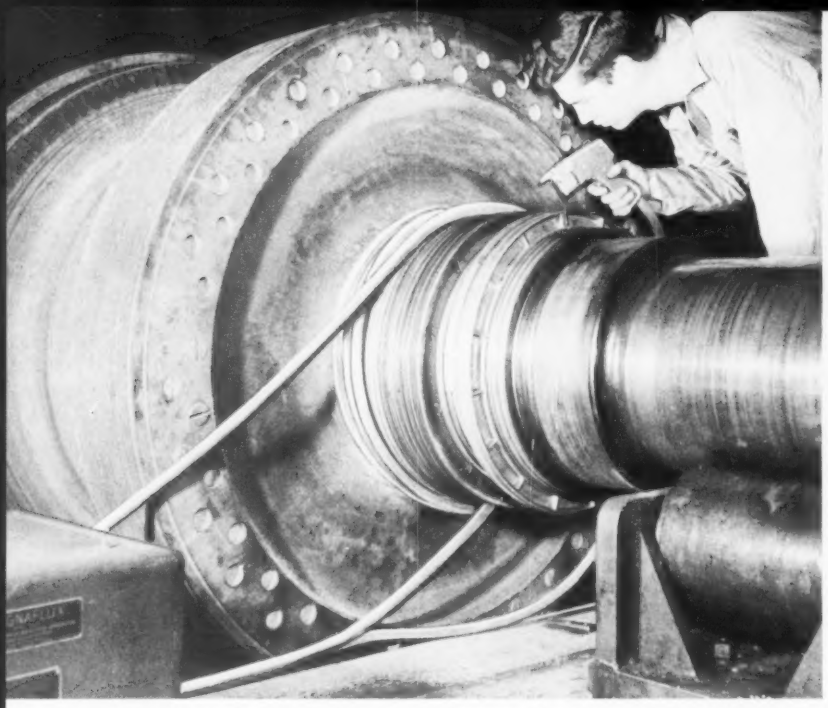
Impurities in the form of moderate amounts of oxides, scale, paint, surface roughness or dirt have little or no effect considering the 2% full-scale accuracy of some instruments. This feature is a big advantage. Flat area of ½-in. diameter is usually needed for readings and you don't have to make electrical contact with test piece.

As mentioned, eddy currents are induced in metal when an alternating-current coil is brought near the metal specimen. Size of these currents depend on potential and frequency of alternating current, the permeability and conductivity of the specimen and its position relative to the coil. Most eddy-current equipment operates in the long-wave range below the standard broadcast band and include the audio frequencies. In the testing of nonferromagnetic metals, frequencies between 1 and 500 kc are common, depending on application. Ferrous metals are usually tested at lower frequencies.

Fact that many physical properties of light metal alloys are related to conductivity expands the usefulness of this simple nondestructive test.

Sorting metals and alloys is another use. Reason: most nonferrous pure metals can be easily distinguished from one another by their conductivities.

One interesting device now on the market is the *Probolog*, used to scan boiler tubing. With all the development work going on in Europe and in this country, indications are that many new eddy-current testing devices will be developed in the near future. It will pay you to keep an eye on developments as they come along.



SPRAYING MAGNETIC POWDER onto this steam-turbine rotor, while electric current is passed through magnetizing cables around shaft, makes fine surface cracks visible

CABLES and prods from the portable unit magnetize the ship's tail-shaft for testing

Magnetic-particle inspection

Magnetic-particle inspection is a practical means for spotting close-lipped discontinuities at or near the surface of a part. Both the wet and dry methods are presently available.

Discontinuities in a magnetized material give rise to localized leakage fields. And these fields serve to attract finely divided magnetic particles. The latter point a finger at the defect, mark its extent on the surface of the part under inspection.

Both direct and alternating currents are used for magnetizing. Dc is useful in finding subsurface discontinuities and is commonly used for inspecting welds and castings. Ac is usually employed when checking highly finished machined parts.

Wet-method technique uses a paste mixture of magnetic particles combined with oil or water. The part to be inspected is either dipped into the mixture or the mixture is flowed over the piece. In the dry method, which is more sensitive to subsurface defects, magnetic powder is dusted or blown over the part to be inspected.

For many applications magnetic particles are coated with a fluorescent material and used in conjunction with black light. Thus, the resultant indication glows and attracts the eye. In effect, this increases the sensitivity of the inspection.

Portable magnetizing equipment is well adapted to heavy castings or weldments difficult to move, or on fixed structures. Portable magnetization takes magnetizing source to the object being magnetized. A current of 500 to 6000 amperes and low voltage between 4 and 18 volts is used.

Two magnetizing means are available—heavy insulated cables coiled around parts, or prods for electrical contact to pass current through local areas of parts. Latter magnetizes with an internal circular field.

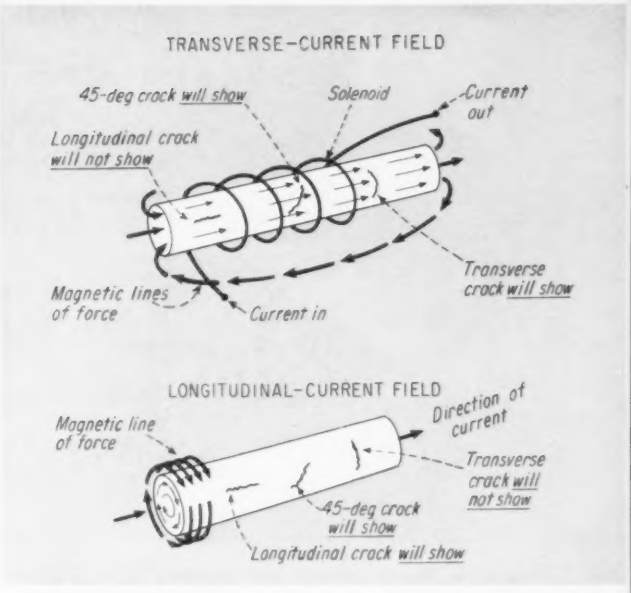
Stationary equipment does the job for smaller parts, for hand or automatic inspection. But in either case, parts are magnetized with a coil that induces a longitudinal magnetic field in the part. Alternate method: parts are clamped between two contact plates that pass current to create a circular magnetic field within the part. Often, parts are magnetized in both directions during inspection to show up defects in transverse and longitudinal direction.

It's generally agreed that an ac supply is practical only when surface defects need to be located. Ac sources are less costly than dc, have advantage of not indicating confusing subsurface defects—especially when they aren't important.

Dc magnetization is generally considered where subsurface and surface crack-like defects must be found. With dc, magnetic field extends within the part itself, and magnetic leakage fields are produced on surface by interruption in magnetic path below the surface.

Half-wave dc is a practical supply for subsurface defects, especially where outer surface is rough as on casting or weldment. Current is rectified half-wave from a single phase ac source at high amperage and low-

PERMANENT MAGNET leech and prod locates defective welds in the steel structure. Leech enables one man to make these tests



MAGNETIC INSPECTION considers fact that discontinuities in magnetized material will give rise to localized leakage fields

pinpoints flaws near the surface

voltage level. Most fabricators of heavy industrial equipment use such tests to check for cracks on welds and castings. Heavy thick welds can be inspected several times during the building up of the weld, after each welding pass if desired.

Dry magnetic powders are used for most portable types of inspection. Red, gray or black colored powders give needed contrast with color of part being tested. Dry powders permit maximum sensitivity for deep, subsurface crack-like defects.

Wet magnetic particles are usually paired off with dc for finding small subsurface seams and inclusions within a few thousandths of an inch below the surface.

Many standard sizes of portable equipment are on the market, varying from small hand-held magnetic yoke to large 6000-amp heavy-duty power units. Smaller sizes (up to 1000-amp capacity) are less sensitive, their usual output is ac. Higher-amperage group, supplying 3000 to 6000 amp, can be had in ac or dc. When inspecting medium-sized welds and castings, the equipment most widely used handles both ac and half-wave magnetizing current. Operator may select and control sensitivity in finding only surface cracks with ac or he may find surface and subsurface defects with half-wave current. All equipment larger than the 500-amp size operates from 220 or 440 volt, single- or 3-phase ac supply lines.

Hand-operated stationary horizontal equipment is seeing wide use. Units usually have a built-in tank to keep wet particle bath agitated and to supply a hand hose for the operator. Almost completely automatic magnetic-particle inspection units are in use. Here, inspection is carried out automatically on a steady flow of parts passing on a conveyor.

Principal limitation of the magnetic-particle method is that it applies only to magnetic materials and is not suited for very small deep-seated defects. Deeper the defect is below the surface, larger it must be to show up. Subsurface defects are easier to find when they have a crack-like shape, such as lack of fusion in weld. On large, heavy objects, when extremely sensitive inspection is desired, operation takes more time. This holds true on medium-sized critical parts like aircraft propellers. With magnetic-particle testing, surface to be inspected must be available to operator. This means shafts or other equipment cannot be inspected without removing pressed wheels, pulleys or bearing housings.

Advantages are many. Magnetic-particle testing can be used on magnetic type material, which is very common in industrial products. It is a positive method of finding all cracks at the surface. And because cracks at surface are most serious and may lead to failure, this is important. Method is flexible and permits effective use of portable equipment. Cost of both equipment and man-hours required for test compares favorably with that of a simple visual inspection method.

Over 20,000 magnetic-particle inspection units are used in over 3000 U.S. manufacturing plants, including all industries from aircraft to refineries and power plants.

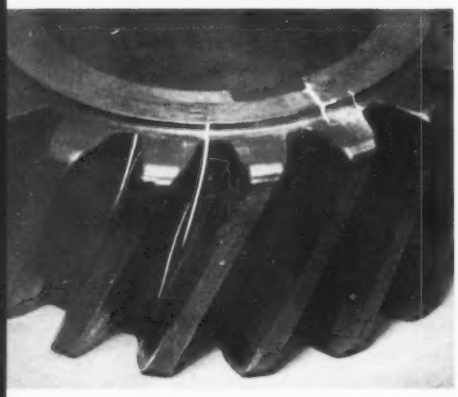
Inspecting basket strainer for defects

Black light makes

Black light is the popular name for invisible radiations in the near-ultraviolet range of wave lengths. While black light isn't new, industry is becoming more aware of the wide variety of applications that hinge on just one of its characteristics. That is, black light, though not directly visible, causes many materials to fluoresce or glow in a visible range of light, making it easily seen by the naked eye.

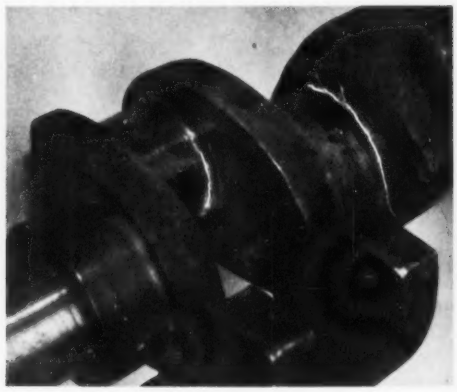
Black-light applications are for detection. Variety is in type of detecting jobs that black lights perform. For example, they may be used to (1) locate or detect fungus growth (2) detect (and trap) rodents (3) examine certain foods for freshness, contamination or rot (4) prospect for certain minerals. Industrial applications include (1) finding leaks in fuel, hydraulic and pneumatic systems (2) inspecting vessels for leaks (3) determining completeness of lacquer or protective film

Here are some of the things you see with black light



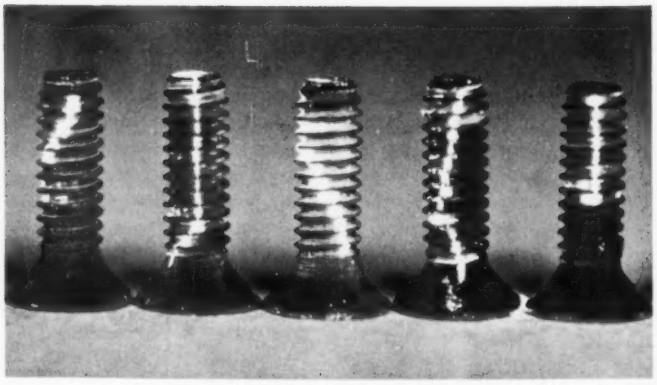
Light finds gear cracks . . .

turbine-blade cracks . . .



crank-fatigue cracks . . .

heat cracks in chisel . . .



and seams and heat cracks

faults easy to see

coverage (4) insuring part cleanliness. Common and important uses of black light in connection with fluorescent penetrants are in detecting cracks and pores that are hard or impossible to find with the unaided eye.

Black lights are used for various types of industrial inspection. Systems concentrate fluorescent materials at dicontinuities open to the surface in inspected parts. Passing the part under black light of the proper intensity and wave length causes the fluorescent material to glow, thus sharply defining the presence as well as the extent of the defect.

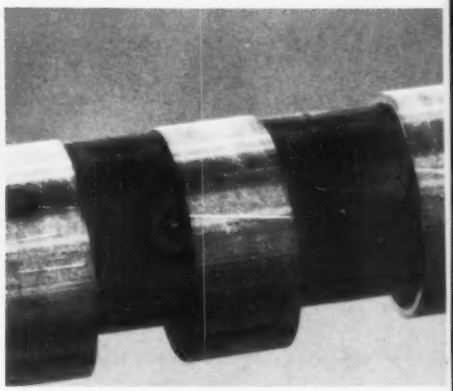
High-pressure-type black-light sources produce enough intensity and the proper wave length for practical testing uses. Commonly used fluorescent materials are designed to give best results when they are excited by wave lengths of 3650 angstroms. Lights are made to match this just as closely as possible to get the best results.

Such lights have a special filter which eliminates almost all of the visible light emissions. The ultraviolet light transmitted by the filter is not harmful to either the eyes or the skin. An unusual haziness noted when looking directly into the light is due to the natural fluorescence of fluid within the eyeball. But there's no harmful effect, so long as you keep the filter in its proper place.

Light recommended for field testing is the 100-watt size, used where it's easier to move the light than the part being tested. This size is also used to inspect parts with a complex shape or holes where, under general illumination, part itself might cast a shadow on the inspected area. Extremely critical inspection of very small parts also can be carried out with these 100-watt lights. You can get 400-watt light for inspections to supplement the smaller spotlight usually used on medium- to large-sized parts. You'll find black light a handy maintenance tool.

extrusion defects in aluminum . . .

casting crack . . .



steel-ring seams . . .

Fluorescent-magnetic-particle tests

This method is similar to the visible wet method. But, inspection materials are specially developed particles that glow under black light; particles are fluorescent as well as magnetic.

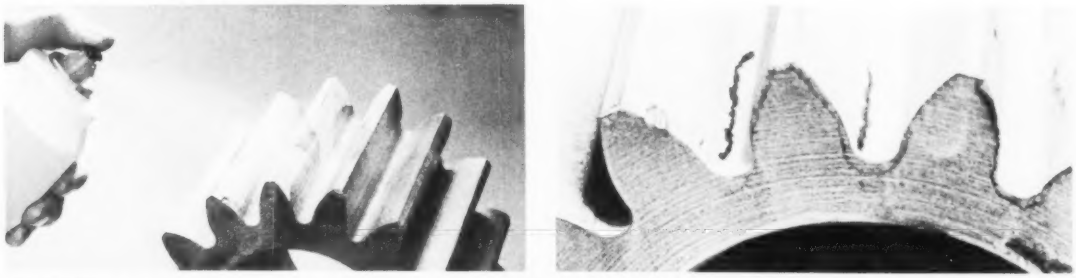
The method is used for quality, maintenance inspection control and for salvage work in all fields and industries. It can be used to test all ferromagnetic materials.

Advantages: (1) Indications glow in semi-darkness under influence of near ultraviolet (inspection rate is thus increased and cost reduced because of ease in seeing indications). (2) Small defects in parts with dark surfaces, such as rough forgings, are easily found. (3) Glowing indications are independent of shape and color of the part.

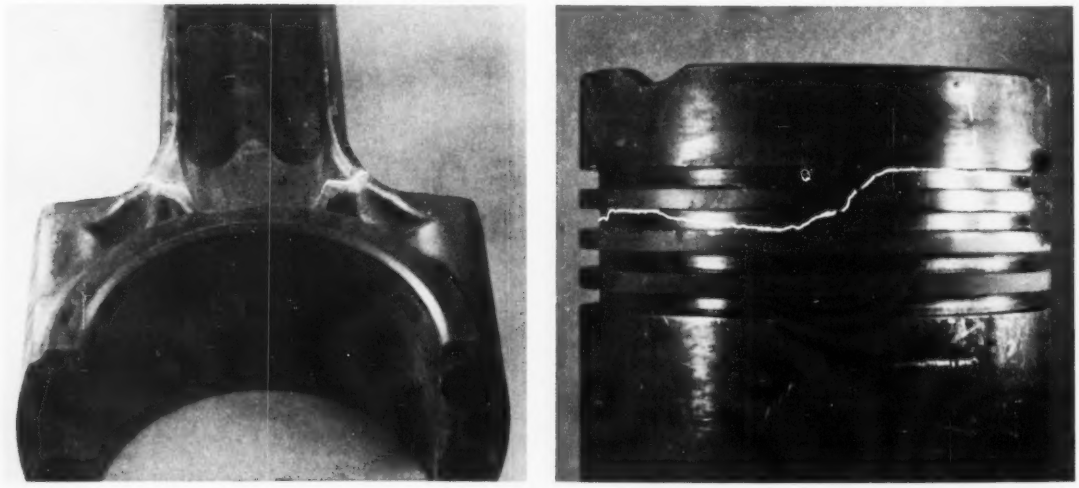
Disadvantages: Only magnetic materials can be tested; flaws not open to the surface or near the surface are difficult to find.

Penetrant tests use fluorescent

WHITE DEVELOPER background helps detect any surface imperfections by absorbing highly colored dye fluid from defects



DEVELOPER is sprayed onto gear from spray-on pressure can. Defects in gear show as colored indications, are easy to see with eye



FLUORESCENT PENETRANT shows brilliantly under black light. Here, cracks show up in connecting rod and diesel-engine piston

liquids, dye and black light

Fluorescent- and dye-penetrant method

Penetrant inspection methods are normally used for examining nonporous materials for defects open to the surface. Materials tested are aluminum, brass, magnesium, stainless steel, titanium, ceramics, carbides, glass, plastics, etc.

Surface defects found are all types of cracks in connection with welding, forging, grinding, fatigue, shrinkage, etc; porosity, seams, laps, cold shuts, lack of bond between two metals, etc. You can test almost any nonporous solid, ferrous or nonferrous.

Because penetrant methods are restricted to the location of surface defects and because part cleanliness is of the utmost importance, these methods have been largely channeled to the inspection of nonferrous and nonmagnetic materials.

Penetrant inspection consists normally of four steps: (1) apply penetrant (2) remove excess penetrant from surface (3) develop indication (4) inspect.

Fluorescent penetrant contains a material which fluoresces brilliantly under black light. Indications of defects appear as fluorescent lines or dots against a nonfluorescent background.

Dye penetrant contains a visible dye, usually red. Indications of defects appear as red lines or dots against the white developer background.

Dye-penetrant method

Apply dye penetrant to part by dip, brush or spray and allow it to dwell for the specified time. After suitable penetration time, remove excess penetrant from surface and apply a developer in the form of a thin coat. Penetrant entrapped in a defect is brought to the surface by action of the developer. Cracks are detected by the contrast between the white color of the developer and the red penetrant.

Portable spray-on dye penetrant kits are widely used in plant maintenance programs for periodically checking critical lifting equipment such as crane hooks, or for spot-checking critical machinery parts during overhaul.

Advantages of the dye-penetrant method are: it provides fast, on-the-spot inspection during overhaul or shutdown periods; initial cost of test is relatively inexpensive. A perfectly white or blank surface indicates freedom from cracks or other defects that are open to the surface.

Disadvantages are: it's not practical on very rough surfaces and color contrast is limited on some surfaces; it detects only defects open to surface.

Fluorescent-penetrant method

Apply penetrant to part by dip, brush or spray. Allow suitable time for penetrant to enter defects. Then, wash excess penetrant from surface with water spray. When using a wet developer, dip part into developer suspension, dry and inspect—in that order. If dry developer is used, dry the part *before* applying the developer.

Use of the newly developed, more sensitive post-emulsified technique adds an emulsifying step just before washing. Otherwise, the process is the same as described above.

For portable applications, all materials are available in pressurized spray cans. Use a spray cleaner to remove oil and grease from the part. Then, spray penetrant on the part, wipe excess penetrant from surface with spray cleaner. Next, spray on the developer and allow it to dry. Inspect the part under black light.

Leak tests are conducted by applying penetrant to one surface of weld or casting and inspecting the opposite surface under black light for glowing penetrant indications. Because of water-washable penetrants and maximum sensitivity possible with the fluorescent penetrants, this method is popular for volume inspection to locate surface cracks and porosity in quality nonmagnetic parts, such as gas-turbine buckets, and stainless-steel, aluminum or magnesium parts that are cast, forged or rolled. Parts can be run in batches. Fluorescent indications of defects provide maximum contrast against the dark nonfluorescent background of part's surfaces. Viewing the defect indications right on the part itself, at location of defect, simplifies interpretation.

Advantages: The test is positive even on rough surfaces; operation and technique are easy; location and size of part's defect are marked for visual inspection.

Disadvantages: A black light operated from a 110-volt power source is needed; only clean defects open to the surface are detected by this method.

Filtered-particle test

POROUS ceramic-tube crack is seen with black light

Filtered-particle inspection is for porous materials, such as unfired clay, concrete, carbon, carbides and some powdered metals. High-tension ceramic insulators are thus tested before fire-finishing. Cracks occurring in the unfired condition always open upon firing. As a result, an expensive insulator may be scrapped because of a crack introduced during manufacture—but prior to firing. Now cracks caused by imperfect casting, drying or handling can be eliminated by using filtered-particle inspection before firing.

Carbon products are also tested to detect cracks in the fired state. Sintered materials, such as tungsten and titanium carbide, are thus tested before machining. Because this material is expensive, nondestructive testing here pays big dividends. Concrete products are also tested by this method.

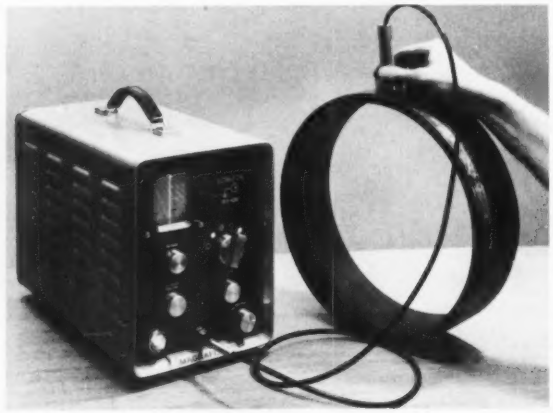
Porous body is flooded with a special liquid suspension of particles by dipping in an agitated bath or by spraying the surface. Differential liquid absorption between a crack and the unmarred porous surface causes the particles to line up immediately along the crack.

Crack indication can be seen at a glance, as photo at left shows. The discontinuity is clearly marked by a readily visible line of colored particles which build up along the defect. Test pays off on expensive ceramics.

Here are some jobs nondestructive

On the past 20 pages we have outlined some of the more important nondestructive tests being used across industry today. There are others which haven't been included because of space limitations. Keep in mind that no single test may do a complete job, even on a single piece of material. And you will probably have to change the test method when you switch to different materials.

Selecting a test method is a custom-fit procedure. And, because each test has it's natural limitations and specific advantages, you must select it with a close eye on the job to be done on the test material. From the equipment builders' point of view, the ultimate aim in using nondestructive testing is to evaluate quality, strength and discontinuities plus serviceability properties of materials *without damaging the part tested.*



PORTABLE ultrasonic instrument has curved crystal

Although some of the following uses for nondestructive tests are of inherent interest to the equipment builder, many can and should be adopted as part of routine plant maintenance. The power-service engineer must look upon these tests as being well within his domain; picking up and continuing where the equipment builder leaves off. Now, in boiled down fashion, here are some of the uses these tests can be put to:

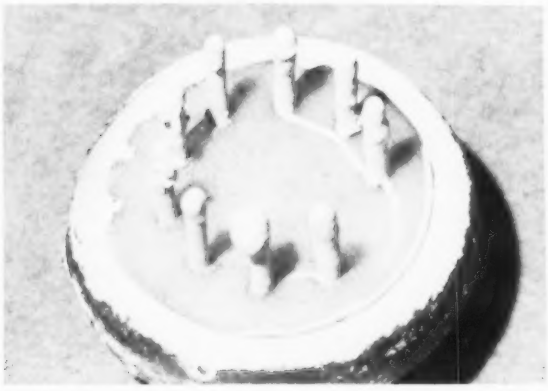
Identification. Selecting, sorting of materials is a big job. It includes checking for accidentally mixed lots, seeing every unit in the lot meets specs.

Checking chemical composition is another task with many facets. It includes analyzing chemical composition of materials and checking all essential processing steps influencing composition. Riding herd on thickness and adherence as well as composition of plated surfaces comes into the picture.

Detecting variations in metallurgical structure comes within the sphere of nondestructive testing. Here we find heat treating or annealing in oxidizing, reducing, carburizing or nitriding atmospheres as likely areas for testing. Also, detecting differences between cast and wrought structures; checking on treatments that influence grain size or grain boundry; heating, cooling, aging processes that cause structural transitions.

Mechanical stress, especially residual stresses following (a) heat treating or processing (b) shot peening or

Electrified-particle test



GLASS-TO-METAL seal cracks are indicated by ridges

Electrified-particle inspection only works on materials such as porcelain enamel, glass, fired nonporous ceramics and plastics. Test falls into two categories—testing ceramic-like materials, and testing glass-to-metal seals.

Here's how these two methods work: (1) When nonconducting material, such as porcelain enamel, is backed by metal, charged powder is blown at surface. If cracked, electrons in base metal tend to leak through and attract the positively charged particles, thus indicating fault with a ridge of powder. (2) When part contains no metal, it's (a) dipped or sprayed with a hot-water-base penetrant conductor which enters the discontinuities (b) surface is dried with cloth, air blast, hot-air drier, etc (c) cloud of fine electrostatically charged particles is blown on nonconducting surface. Powder particles are held electrostatically at defect. They quickly build up a highly visible powder indication that's seen at a glance.

Penetrant and powder used isn't injurious to material being inspected, to operator or to food. Powder is available in various colors to contrast with material's background. Guns and nozzles are used to disperse the powder in a cloud. Each powder particle is dynamically charged by its passage through the gun nozzle. Charge is held when applied to surface of the part. This test should be most helpful for the first-growing glass-lined metals.

testing will do for you

mechanical rolling (c) welding or joining (d) surface finishing including grinding, polishing or chemical treatments (e) case hardening by gas-induction heating (f) bending, forming or similar fabricating steps (g) repeated service stressing (h) loading beyond elastic limit . . . are all candidates for NDT.

Spotting of internal voids and fissures. Here you would be looking for gas porosity in castings, fissures in rails, incomplete penetration in welds, nugget cracking in spot welds as well as laminations in rolled plate and sheet materials.

Locating surface cracks is an obvious application. Here you would be searching for such things as (a) fatigue cracks developing under repeated loading (b) cracks resulting from surface grinding (c) heat treating and thermal cracks (d) seams and laps stemming from rolling and piercing or other hot forging operations (e) cracks developing from surface heat treatment, case hardening, hydrogen embrittlements (f) corrosion pitting.

In more specific areas, NDT is used for:

Detecting internal inclusions in the form of dross in cast metals, slag in fusion weld metal, electrode pickup in spot welding, internal parts misplaced or loosened during assembly, foreign bodies rolled or forged into a component.

Gaging dimensions. Within this category fall checks on (a) wall thickness of tubes and pipes where internal surfaces are not accessible (b) thickness of sheet metals moving at high speeds (c) fluid levels in closed containers, such as molten metal level in furnaces and cupolas, radioactive materials in pipes and tanks (d) displacement of hidden structural parts operating under high speed or vibratory loads (e) clearances between electrodes in sealed vacuum tubes (f) locating internal insulation and bushings in electrical apparatus, and, once again, measuring plated thicknesses.

These are but some of the many things that NDT will do for you. The field is relatively new with techniques being developed almost daily. For information on the mechanics of setting up a program of NDT in your plant not covered in this report, write to *Society for Nondestructive Testing, Inc, 1109 Hinman Ave, Evanston, Ill.*

Acknowledgments

POWER is deeply indebted to most of the many manufacturers of nondestructive equipment for literature, illustrations and technical help. We especially thank the following individuals: F Catlin, G Corney, J Folz, H Hampe, C H Hastings, R Hoschshild, R E Kleint, Prof R C McMaster, C D Moriarty, J Morris, H D Richardson, H N Staats, S Tour, R Turner, R W Wilson and P D Johnson, Secretary of the Society for Nondestructive Testing, Inc.

SOCIETY FOR *Nondestructive* TESTING, INC.

Dr. Robert C. McMaster, Chairman
Handbook Executive Committee
c/o Department of Welding Engineering
Ohio State University
Columbus 10, Ohio

Mr. Steve Elonka
POWER
New York (36), New York

January 14, 1958

Dear Steve:

We who use nondestructive tests in modern industry believe that informing management of their advantages, limitations, and capabilities is an important job.

Nondestructive testing is a powerful management means of lowering costs and increasing the productivity and profitability of industry. It saves man hours and machine time by eliminating wasted effort on defective materials. It improves product quality and builds goodwill for the manufacturer. It insures continuity of production and service without failures.

Nondestructive testing is not a luxury; for modern industries it is the key to survival. In critical industries producing airframes, jet engines, guided missiles, and nuclear power components, firms which failed to use nondestructive tests adequate to insure product reliability have already lost their share of the market. Their competitors who pioneered the application of nondestructive tests in their fields are the only producers receiving contracts and selling such products today. As competition increases, and as engineering materials operate under still more severe conditions, other firms will survive or fail in proportion to their managements' intelligent use of nondestructive tests.

Profits have gone to the foremost, not the hindmost, in this race. Among advanced industries, investments of ten to fifteen per cent of production costs in nondestructive testing have lowered total production costs by thirty to forty per cent.

Alert management is exploring the costs and benefits offered by nondestructive tests within its plants. Intelligent use of nondestructive tests to implement management policies is good business and a vital part of management's function. Informing management, as your survey in POWER can do, is a vital service which can pay significant dividends to your readers.

Sincerely yours,

Bob McMaster

Robert C. McMaster, Editor
SNT Handbook of Nondestructive Testing

Your page for **comment**

BOB BELLAS, Assistant Editor

In the realm of moot

I read with interest bordering on amazement your account of Ontario Hydro's serious plan to bury water pipe adjacent to electric power cable in order to increase the cable's capacity (*Reports from the field*, Feb 1958, p 150).

Assuming initial cost of pipe and installation is less than cost of larger-sized cable (which I question if dependability of water system is kept in mind), will water cooling produce desired results? Can municipal water supply be trusted not to plug pipes with scale during life of cable? Is water temperature measured at "pumping stations" a reliable indication that hotspot temperature isn't excessive? Main problem, after all, is the hotspot where soil has low thermal conductivity and can't carry away cable heat.

Where oil-filled cable is used, oil recirculation seems a more practical approach. Where cables must be overloaded because of emergency conditions, flooding ducts has merit. But does intentionally overloading cable pay off? Let's keep our eye on the Canadian experiment.

EMIL WAGNER, *Minneapolis, Minn.*

An elevating discussion

We were very much interested in the article "Lift slab scheme raises generator 40 ft in 20 hours" (Jan 1958, pp 88-89). We have achieved a similar job at the Beautor station of Electricité de France.

The enclosed October 1957 issue of *Etudes & Réalisations* describes the operation. The apparatus used can be taken to pieces and the job was performed in less than six hours.

R CHARRON, *Engineer, Société D'Etudes Téchniques, Paris, France*

EDITOR'S NOTE: *Reader Charron's method appears to employ a demountable gantry-type device set up outside the building wall. Crane's trolley runs on a platform which extends through an opening in the building wall at the desired height (in this case, about 40 ft). Using a straddle lift, trolley picks up generator, trundles it inside building and lowers it in place.*

. . . method described in article looks costly to me —in addition to investment in jacks and steel, etc, unless this can be justified on repetitive jobs or for other lift uses.

The story should have had some specific reference to costs. Other than time involved, this is essentially the only interest except, of course, safety.

Our construction department used cribbing and hand jacks on our recently installed three 100-mw and one 170-mw units. For an upcoming 170-mw installation in 1958 we plan to use a jacking frame set on four-corner column foundations. Cost appears to be the same, though we haven't got complete data on this as yet. Chief aim is to cut time from about 20 to 3 days. This scheme isn't original with us. It was used, I believe, at one of Pennsylvania Power & Light Co's stations.

E C DUFFY, *Vice-President in charge of Operations Long Island Lighting Co, Mineola, L. I.*

Clearing the air

The drawing above the letter from S R Higgins (*Plant problems*, Dec 1957, p 159) shows the safety valve installed on the receiver. It also shows two stop valves in the line between safety valve and compressor. It does *not* show a safety valve on the intercooler, though it's plainly seen in the picture of the unit on page 158.

Safety valve's function is to protect equipment from overpressure. And by equipment we mean any part of a system carrying pressure above atmospheric. It's a common fallacy to assume that the receiver alone needs protection.

System shown in the drawing could be changed two ways to get proper protection: (1) Relocate safety valve as close as possible to the compressor and ahead of the first stop valve. (2) Remove both stop valves—giving clear passage from compressor to tank—though this is the least desirable method. Any abnormal flow constriction could cause excessive pressure in lines, aftercooler or separator. Even if temporary, it might be enough to cause severe damage before it could be relieved.

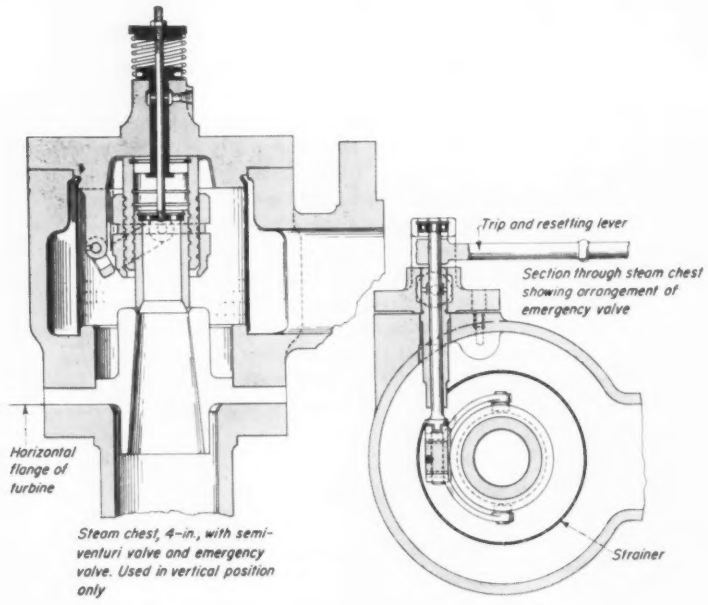
W A PAGE, *Old Chatham, N. Y.*

A word to the wise

"Think ahead . . . or pay the price" (Feb 1958, p 67) succinctly sums up a thesis that is rooted in one of the fundamental laws of the jungle—*survival of the fittest*. Medical science hints, not entirely facetiously, that our descendants won't have legs because of our fondness for riding everywhere. Apropos of letting "experts" do our thinking—let's not get too comfortable on our mental posteriors.

L J DELAPLANE, *New Orleans, La.*

Timely **practical ideas** to help solve


Trip and resetting lever
Section through steam chest showing arrangement of emergency valve
Horizontal flange of turbine
Strainer

Steam chest, 4-in., with semi-venturi valve and emergency valve. Used in vertical position only

A better governor valve for small steam turbines

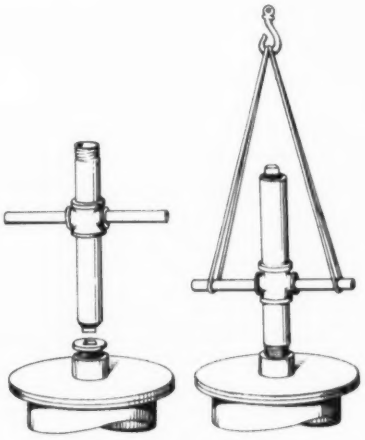
Here's a novel governor valve and emergency trip valve assembly for small steam turbines. Valve is designed for use in a vertical position to eliminate as much friction as possible. (Friction is caused by valves rubbing on metal when used in a horizontal position.)

Venturi nozzle shown allows a much smaller valve to be used than with a double-seated valve. Also, the valve used with the venturi has no dynamic action which occurs frequently with a double-seated governor valve. Valves and guide are made from stainless-steel tubing or centrifugal cast stainless. Venturi is made from cast iron or cast steel.

Because of governor valve's small diameter, I was able to incorporate an emergency trip valve in the same steam chest. Assembly of the two valves, plus an extra large steam strainer, goes in practically the same sized steam chest that's used for a double-seated valve.

A section through the steam chest shows how connection to emergency valve is brought out to connect to trip mechanism. To inspect valves, shaft assembly to emergency valve can be withdrawn by removing two nuts. Steam-chest cover, valves and strainer can be lifted out as a unit; saving time on those maintenance jobs.

C MACDONALD, *Wellsville, N. Y.*



Easy way to lift a manhole cover

We have several buried tanks with ground-level manways, each with a 3-in. gaging nozzle. Both of these must be opened frequently. To simplify this task we have devised the tool in sketch. It has a 3-in. pipe threaded at one end, fitted with a 1¼-in. pipe tee handle. Short section of 3-in. round stock is machined with a square boss to fit into socket in nozzle plug welded into second end.

First sketch shows how we remove or tighten the plug. The tee-handle provides enough leverage for the job.

Second sketch shows how to lift the manhole cover. After the plug is removed, threaded end is screwed into the nozzle. The tee handle provides a convenient attachment for a sling, enabling our mechanics to lift the cover with our "doodle-bug" crane. This prevents damage to cover gasket or gasket faces as often happens when cover is lifted with hooks under rim.

T R HARE, *Berkeley, Calif.*

Insulation saves the day

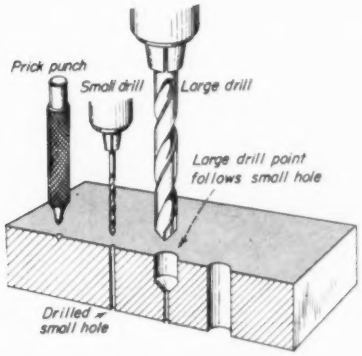
Our material "freezes" at 80 C in 2-in. pipelines. Hence we fastened ⅜-in. copper tracer lines in spirals with fastenings at 18-in. intervals. Lines were covered with manganese-asbestos insulation and 22-gage galvanized sheet was wrapped around and tied with 14-gage wire. With steam at 125 psi, we had block-ups that were probably caused by bulk mass, lowering the line temperature faster than it could be heated.

That called for action. During a 3-day holiday the insulation was stripped off, all loose tracer spots fastened securely and the line covered with aluminum foil. We lapped over 4 in. at horizontal and vertical joints. Original covering was restored with a rubberized roofing stock laid on with 3-in. laps. Then the galvanized sheets were reinstalled. We have not had any freeze-ups since we made these changes.

P C ZIEMKE, *Clinton, Tenn.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor



Large hole drilling kink

Here's an easy way to drill a large hole accurately. First, be sure to lay out the hole where needed. Next, use a prick punch with about the same angle point as the drill to be used to start the hole. Next, drill a small hole to the desired depth. Then drill with the larger drill. This small hole helps keep large drill from walking, relieves strain on large drill point.

C H WILLEY, *Penacook, N. H.*

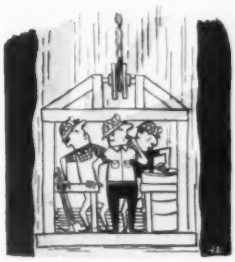
Steam waste discovered

A building served by central-system steam showed a uniform consumption of about 100,000 lb steam per month throughout the year. This steam was purchased at a cost of $1.70 per M lb.

No reason could be found for high steam consumption. Condensation meter was checked and replaced, but meters were found to be in order. Yet consumption continued at the same high level. All the steam traps were checked and even though the condensate was cool, the rate of usage was high.

Eventually, we found a defect in a hot-water heater booster coil, which had leaked from the time of installation. Cold water was being sent to the sewer through the condensation meter at the rate of 5 gpm or more. There was a double loss, both in water and in the cost of steam which was being maintained at a false level because of the leak.

E F WEHLAGE, *Fairport, N. Y.*



What would you have done?

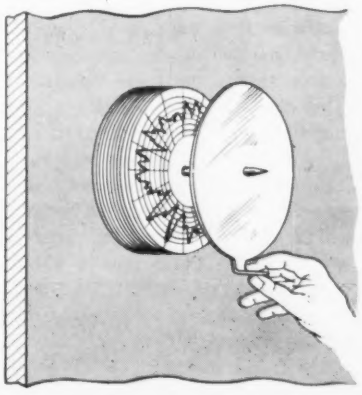
Our little 2-cylinder steam hoist was never too powerful in the beginning of the shaft-sinking operations. As the wood frame of the cage became thoroughly water-logged and an increasing length of rope was suspended in the shaft, it labored heavily. Then, in transporting men and materials, it started showing signs of old age.

Steady lowering operations of steel, concrete and drills produced enough friction to char the basswood lagging on the brake band. Under such conditions, if the hot rig was left unattended for a period, the brake cooled and permitted the cage to slowly slip down the shaft.

Original plan was to slip an I-beam under the cage and let the cage come to rest on it. But the horsepower exerted wasn't enough to move a full load up the shaft and off the beam. And the beam was hard to handle and keep at hand as the sinking operation progressed.

Solution was to clutch the hoist engine to the drum with the brake fully locked. Then, as a final precaution, we slipped a wide wedge in the spur-gear teeth to make doubly sure that nothing would revolve. Wedge handle was painted red to warn the returning engineer that the wedge must be removed before resuming hoisting operations. What would *you* have done?

P C ZIEMKE, *Clinton, Tenn.*



Handy chart keeper

When a large number of charts and recordings are kept, holder, sketch, does the job. Fasten pins to wall to receive and hold the charts. Then make a round metal cover with a small handle for convenience. Either tin, sheet metal or aluminum will do.

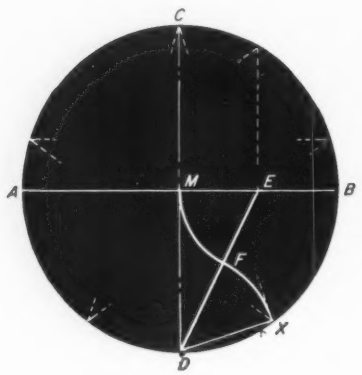
This holder keeps the charts intact when subject to stray drafts or winds etc. It also keeps them clean for future reference.

C HOLLORAN, *Toronto, Ontario*

Turn page for more Practical Ideas ▶

More **practical ideas**

Begins on page 140



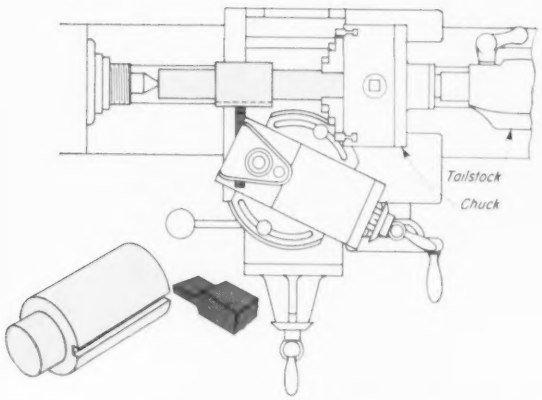
Five sides found easily

Almost everybody knows how to divide the circumference of a circle into three, four or six equal parts. Recently an argument came up on how to divide a circle into five or ten equal parts. Nobody seemed to know. The answer: just follow my sketch.

(1) Draw two perpendicular center lines *A-B* and *C-D*. (2) Divide radius *M-B* into two equal parts *M-E* and *E-B*. (3) Connect point *D* with point *E*. (4) Draw a circle with *E* as center and *E-M* as radius. (5) Mark intersection of this circle and *D-E* as point *F*. (6) Draw a circle with *D* as center and *D-F* as radius.

Intersection with the original circle (point *X*) gives the arc *D-X* which is one-tenth the circumference of the circle.

J De Haas, *Seattle, Wash.*



Here's how you can cut keyways with your lathe

You don't need a milling machine or shaper to cut an occasional keyway in your maintenance shop—not if you have a lathe. Trick is to supply power to work the tool back and forth without rotating the work between centers. This is done by attaching a chuck to the tailstock with a special adapter. Chuck on tailstock holds work stationary, while head stock center revolves. A Morse taper with threads on the outer end, similar to those on the lathe spindle nose, will hold the chuck. Device permits many setup variations since the tailstock can accept any accessory that screws on to spindle nose.

Mount cutting tool in tool post sideways, as shown. You can then make a number of scraping cuts by engaging the longitudinal power feed or the lead screw.

Blind-ended keyways can be shaped if a shallow hole is drilled at the keyways' end. Screw-cutting gear, rather than the longitudinal feed, should be used here. Reason: it can disengage quickly, as soon as tool runs into hole.

C T Bower, *London, Eng.*

Do you know...

when preparing to expand tubes—you should select expander for size and gage of tube? Thickness of seats must be taken into consideration. Expander with correct length rolls should only expand tubes about ¼-in. past the outside of the seat. This is an important dimension to remember. Tubes are often improperly rolled because this item has been overlooked. *Caution*: Don't over roll tubes. Stop rolling when scale starts to flake off the tube sheet.

No valve? Stop flow by freezing

First time you find a line that hasn't a valve to shut off flow without seriously hampering operations, use nature's shutoff method—freezing.

Use scrap lumber to build a box around the pipe to hold crushed ice, salt. Interior measurement will vary with quantity needed. An average job needs 50 lb of crushed ice, mixed with 12 quarts of coarse salt. Batch freezes a small water line in about 10 minutes. You can drill a small hole on the downstream side to make sure line is frozen.

Only freeze metal pipes — plastics become embrittled when frozen. Lacking salt-ice mixture, many plants now stock dry ice that lends itself to freezing jobs. But wear gloves to keep from "burning" your skin with 115 F minus carbon dioxide. CO_2 has added advantage of leaving no messy residue to clean up.

P C Ziemke, *Clinton, Tenn.*

My biggest boner

Please turn to page 220

WELBOND®
is the valve
for high pressures
for high temperatures

Welbond Valves are winning acceptance among modern steam plants for all high pressure, high temperature valve service.

Superheater vents and drains, water wall drains, water column emergency shut-off, strainer blow-off, economizer drains—are just a few places where Yarway Welbond Valves are proving their mettle.

These special Welbond features insure improved valve performance:

- **Stem** of 321 stainless steel, used with special **packing** to prevent stem corrosion
- Easy and quick **accessibility.** All working parts removable through yoke. Jack action of stem forces out old packing
- Non-distorting, thermally-compensated **seat**
- Ventilated, easy grip **handwheel**
- **Streamlined flow** through body

For full information, ask your Yarway man or write for Bulletin B-452.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

Yarway Welbond Valves are available in nine sizes, ¼" to 2½", angle and straightway designs. Pressures to 2500 psi, temperatures to 1050° F.

YARWAY® WELBOND

. . . a good way to specify high pressure/high temperature valves

These plant problems could well be yours...

The problem

What's a good program for maintaining steam traps?

I've recently taken over responsibility for steam and water services in a medium-sized chemical plant. Judging from past maintenance records, we need to organize our steam-trap maintenance and testing on a regular basis. Also, our maintenance men have no definite established system for performing tests.

Our top steam pressure is 200 psi. We also have 50 psi steam for process heating and 5 psi for space heating. Uncontaminated condensate is returned to a tank at the steam plant.

I'd like suggestions on frequency of testing, testing and checking procedures and how to put maintenance on a program basis.—*EEG, December Power*

The solutions

This maintenance program pays dividends

There are many factors to be considered by *EEG* in establishing a sound trap-maintenance program. But, the results are well worth the effort needed to set it up.

Frequency for cleaning and testing traps can only be determined by trial. It is directly governed by condensate purity and return-piping condition. Proper return-line corrosion control with neutralizing or filming amines will eliminate 90% of trap trouble caused by corrosion products lodging in strainers and traps.

Our hospital is three years old and we have 85 traps located in widely scattered areas. Pressures are 125, 50 and 6 psi. For the first 18 months, traps and strainers were cleaned at 6-month intervals. But results were so good that we stretched the interval to 12 months. We now inspect strainers annually and at the same time test trap performance with temperature crayons (POWER, May 1957). We can check all our traps in one day, whereas three days were formerly needed. It also eliminates the need for blowing flash steam from trap-test cocks, which was very unnerving to female employees in areas such as the laundry. In three years only one trap has needed a new seat and disk and that one was used on 125-psi service. With proper treatment, present-day traps will give good service with a minimum of attention.

G R DIEGLE, *Marion, Ohio*

We now test with temperature crayons

Like *EEG*, many of us are aware of the need for effective trap maintenance to reduce costly steam waste. But many programs are not even started because of the number of man-hours needed to set it up.

Steam traps that are hung up closed are easily detected. But those passing steam are hard to detect until inspected internally or tested.

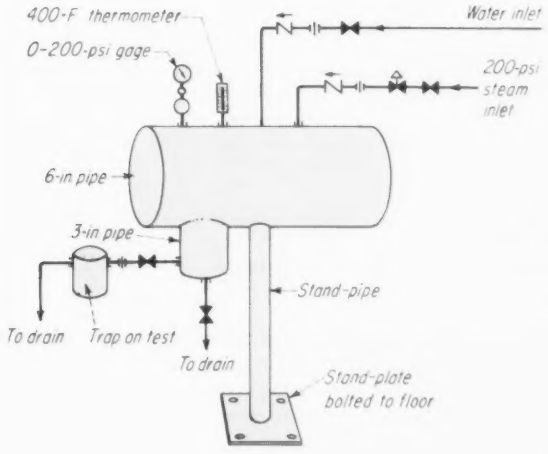
In last May's POWER, an article by R C Bellas paved the way for me to set up an effective steam-trap maintenance program. We use temperature indicating crayons. With this method, traps are inspected semiannually and when suspected of blowing through while in service. Every year, stop valves are packed, strainers cleaned and all traps inspected internally.

Testing with crayons reduces the large amount of man-hours involved. Thanks to Bob Bellas and POWER for passing this idea along.

E SIDEWITZ, *Brooklyn, N. Y.*

...Here's how *Power* readers would tackle them

ROBERT MARKS, Assistant Editor



Set up and equip a trap-test stand

First step in starting a maintenance system is a thorough trap survey. List all traps by location, make, size, type and working pressure. Use numbering tags and mark location on plant drawings. Then check your stores to make sure that spare parts and traps are available for all sizes and makes.

Next, allocate and set up a suitable test area. Equip it with a work bench, vises and enough maintenance tools. It should also have a test header supplied with steam and water line, sketch, above. Feed steam in through a pressure-reducing valve to test traps at actual working pressure. Use water line for trap priming before test and for cooling afterwards. Have enough drainage for both condensate and water. Discharge trap to atmosphere during test. This lets you witness the cutting out action more easily.

Inspection procedures are quite simple. First touch the trap. If it's cold, remove, clean, replace worn and defective parts; then test on header and return to service. If trap is hot, listen carefully to the shutoff mechanism after the trap dumps its condensate. Another way is to check temperature difference between the pressure and discharge side with a pyrometer. If these temperatures are the same, you will find the trap is leaking. If the discharge temperature is slightly lower than the inlet, the trap is working right.

A G Wood, *Oakville, Ontario*

Preventive Maintenance Service Record

Description of Equipment			
Trap			
Location in Plant		Type	
End of 200# Line		Bucket	
Manufacturer		Serial No.	
XYZ Company		814	
Size-H.P. Etc.	RPM	Pounds Psi	
3/4"		200#	

Date	Man Hours	Preventive Maintenance Accomplished	Signed
1/3/58	2	Complete overhaul	J Smith

Complete service records are a big help

Keep a preventive maintenance book on all equipment. Any work done should be entered daily. Sample page is shown above.

High-pressure traps, 200 psi and up, should be checked anywhere from daily to weekly. Test medium-pressure traps, 50 to 100 psi, weekly to monthly. Low-pressure traps, under 50 psi, should also be tested weekly to monthly. The 1¼- and 2-in. size traps can be tested more frequently to good advantage. For best results all traps should be removed and all parts examined at least once a year.

J P Timmons, *Brooklyn, N. Y.*

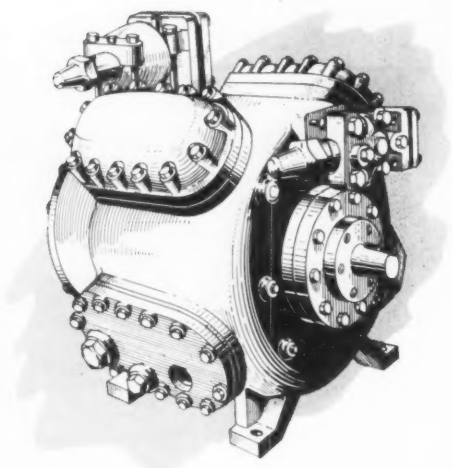
Here's a maintenance-program check list

Every good maintenance program must include: (1) Test bench for testing traps under actual conditions. This requires a source of live steam and a small pressure-reducing valve to reproduce pressures found in the plant. (2) Full supply of parts needed for overhaul. (3) Pyrometer for testing traps for heat change before removing them from the line. (4) Record book noting the work done and date tested.

Traps should be tested periodically with the pyrometer. Actual testing interval depends on type of service —constant or intermittent. Trap should show a temperature drop of 30 to 40 F at a point two feet from the trap on the discharge side. If these temperatures are equal, the trap is blowing. If the drop is much greater than this, the trap is partially plugged. Both cases warrant removal and repair.

C W Parks, *Overlea, Md.*

Turn page for info on compressors ▶



The problem

Why does refrigeration compressor run continuously without reducing chilled-water temperature?

I'm building engineer for a commercial structure that is equipped with two 150-ton centrifugal refrigeration compressors for its air-conditioning system. Chilled water is supposed to leave the evaporator at 50 F (a 10-F temperature drop). Leaving-condenser-water temperature is 95 F (a 10-F temperature rise). Evaporator passes 320 gpm; condenser passes 402 gpm. Motor is 120-hp, 208-v, 3-phase. We've had these machines for seven years, and until recently they've worked fine. Lately, however, the machines have been running almost continuously without depressing chilled-water temperature the required amount. I'd like to know best approach to this problem. — *RSM, December Power*

The solutions

Want some help on plant problems? Send us any of your design and operating headaches. We'll put *Power* readers to work on them

Use this handy chart to trouble-shoot

Causes	Symptoms	Remedy
Load exceeds machine capacity	Temperature in conditioned area too high	Check load conditions in the area
Refrigerant charge low	Evaporator temperature too low	Add proper refrigerant and check for loss
Thermostatic control out of adjustment	Branch line pressure from thermostat too low	Repair or readjust
Suction vanes closed	High evaporation temperature	Check pneumatic control system and linkage
Loss of rib gaskets in head	Sudden chilled water temperature decrease	Replace gasket
Repaired motor lately?	No refrigerant capacity	Reverse rotation

I have worked on systems similar to *RSM's* with machines operating and no reduction in water temperature. Chart, above, summarizes the various causes of trouble.

If *RSM* has a good preventive-maintenance program for his equipment, he should refer to the daily log and weekly readings. This may show when the trouble started and perhaps indicate a quick remedy. The equipment should be given a thorough checkup every six months. If operation is continuous it will pay to run a general overhaul each year and to keep a log of the findings.

B A Crosson, *Cranston, R. I.*

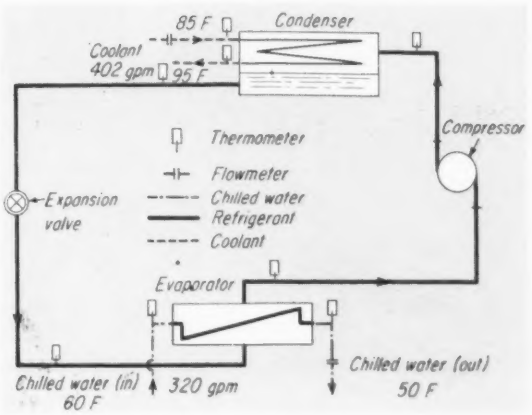
We had a similar drop in capacity

Our 600-ton machine was operating properly, but output was down. So was condenser-head pressure, condensing-water temperature and motor amperes. A careful check of the compressor showed nothing wrong. But refrigerant level had dropped to within ½ in. of gage-glass bottom in our flooded type evaporators. We added several drums of refrigerant bringing level almost to the top of the gage glass. Capacity quickly returned to normal.

Apparently refrigerant level is far more critical in a flooded evaporator than in the receiver of a reciprocating machine. I thought that any level within the range of the gage glass was all right. But apparently a full gage glass is mandatory in my plant.

Toward the end of this past season we again lost capacity, this time for a different reason. The head pressure increased, but condenser-outlet-water temperature dropped. We reasoned that one of the baffle gaskets had broken allowing water to short-circuit. Our condensers are the 4-pass type. At the end of the season, we removed the condenser heads and found the first-pass tubes completely plugged with scale. This built up pressure on one side of the steel baffle, forcing it out of place. Water short-circuited to the third pass. This cut cooling surface in half, making loss of capacity easy to understand.

W J Steinert, *Fresh Meadows, N. Y.*



Check the complete system thoroughly

Sketch, above, shows principal parts of vapor-compression cycle for air conditioning. *RSM* should follow these three steps:

(1) Measure coolant temperature entering and leaving condenser. High-inlet and/or low-outlet water temperature means an inadequate heat-transfer rate. If this is the case, measure cooling-water supply to condenser. Partially closed valves in the coolant circuit on either side of the condenser will reduce flow and limit condensing ability. Inspect coolant piping and condenser tubes for scale and deposits. These reduce water flow, retard heat transfer and lower condenser capacity.

(2) Check evaporator performance by taking refrigerant temperature before and after the exchanger. Fouled tubes lower heat-transfer efficiency and limit chilled water cooling. Measure heat input to evaporator and compare with specifications. Increased heat load from greater conditioned air needs will give higher refrigerant temperature from evaporator. This may superheat the refrigerant, lowering vapor density and reducing mass flow rate into the compressor. Result is a decrease in refrigerating capacity.

(3) Inspect expansion valve and refrigerant piping. Frequent causes of trouble are moisture freezing in the valve and loss of charge in the power assembly. If the valve freezes shut, reduced refrigerant flow to the condenser will lower suction pressure. If it freezes open, system floods and suction pressure increases.

H B WAYNE, *Woodhaven, N. Y.*

Don't overlook these pointers

This check list may give *RSM* the answer to his problem.
(1) Compare present temperature drop across evaporator with readings taken when the machines were working properly. If temperature differential is greater, evaporator or condenser tubes are fouled and need cleaning.
(2) Compare actual quantity of cooling water through the condenser with the design quantity.
(3) Compare actual quantity of chilled water through the evaporator with the design quantity.
(4) Check leads to motor for voltage. If it is lower than nameplate reading, motor speed will drop.
(5) Check quantity of refrigerant in compressor.
(6) Be sure condenser is purged of noncondensables.

P A DETHLOFF, *Chicago, Ill.*

Your March problems

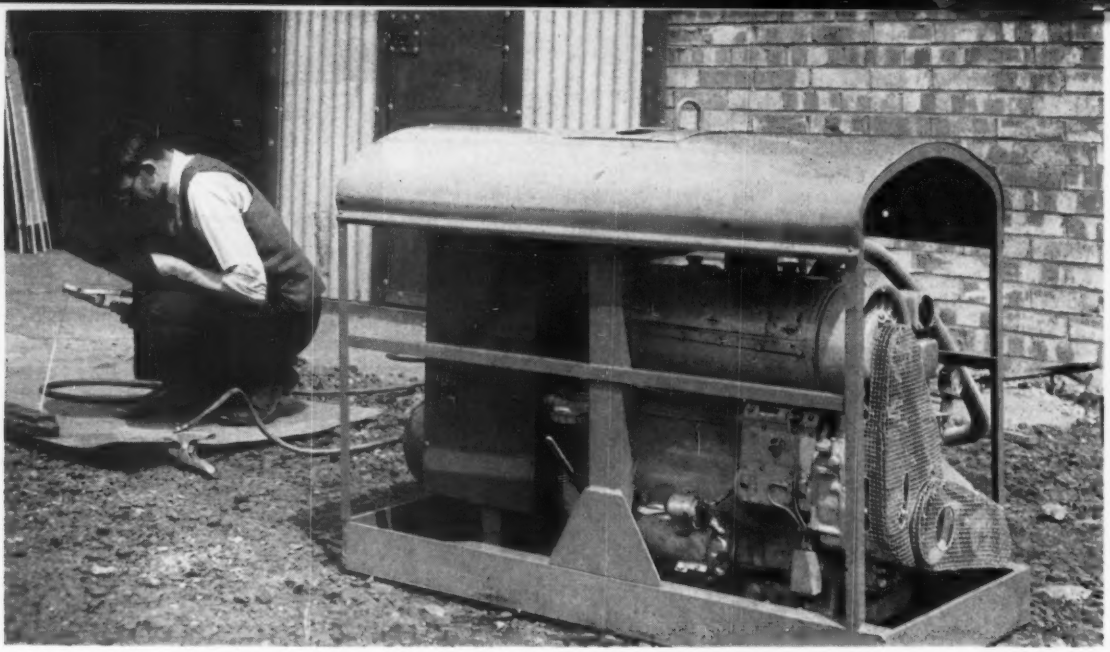
Shall we use evaporators or demineralizers for makeup treatment?

Our engineering department is designing several new central-station power plants. Part of my job involves handling the makeup treatment. We have always used evaporators in our previous systems and are well satisfied with their performance. But many central stations are now using demineralizing equipment. I know demineralizers produce excellent water. But the latest evaporator designs seem to do an equally good job. What are some of the most important factors that should be considered in evaluating the merits of these two methods of makeup treatment? What is the best place in the cycle for the evaporator? Where should demineralized water be added? I'd appreciate hearing how other POWER readers would tackle this problem.—*SJD*

How can synchronizing voltage-regulator accidents be avoided on engine-generator sets?

What happens if a breaker on an engine-generator set accidentally closes in on the bus 180 degrees out of phase with another engine-driven generator already on the bus? Our plant includes a 1000-kw vertical uniflow, two smaller horizontal nonreleasing corliss units and a belt-driven unit; generating at 4160 volts. What happens if a voltage regulator fails in such a manner as to remove all resistance when a single generator is supplying the bus? We normally run with the main and exciter-field rheostats in the "all-out position." Our voltage regulators consist of two rocking-contact type, a silverstat and a carbon-stack type. Have any POWER readers had such experiences? What precautions can I take to avoid these accidents?—*CRB*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches.



WELDING SET is powered by 4-cylinder air-cooled diesel engine. Generator is 200-amp 30-volt machine. All models operate at constant speed of 3000 rpm, or about 1000 rpm faster than other small engines. This packaged unit is easy to move to location

How to

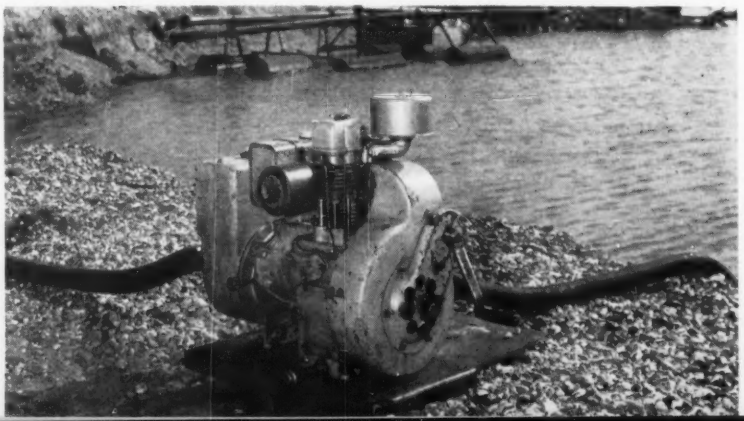
apply portable diesels

Now you can harness this low-cost portable diesel power for many odd jobs about your plant. Range in weight is from 243 lb for a single-cylinder unit to 503 lb for the 4-cylinder model. Output is from 6.25 to 25 hp. All models operate at 3000 rpm, or more than 1000 rpm faster than comparable diesel engines. Because of fuel economy obtained by low power-to-weight ratios that earlier diesels didn't have, they are replacing gasoline engines.

The engines can be used for alternators, cement mixers, centrifugal pumps, fork-lift trucks, dumpers, airport ground servicing equipment and other industrial jobs. In power plants they are used for air compressors, generators, cranes, conveyors and ventilating and refrigeration units.

Manufactured by Petters Ltd, of England, they are distributed throughout the world.—*Courtesy, Brush Aboe, Inc, Woodside, N. Y.*

CONCRETE VIBRATOR is powered by a single-cylinder air-cooled diesel engine



CENTRIFUGAL PUMP is a self-priming unit. It has a maximum output of 13,000 gallons per hour. Power is from a single-cylinder high-speed diesel engine →

(Advertisement)

Trapping Standardization

. . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

4. You can enjoy the advantages of standardized hook-ups.

Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how

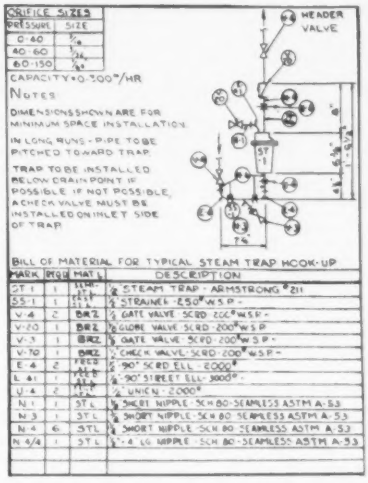

ORIFICE SIZES
PRESSURE SIZE
0-60
60-150
CAPACITY=0-300#/HR
NOTES
DIMENSIONS SHOWN ARE FOR MINIMUM SPACE INSTALLATION
IN LONG RUNS - PIPE TO BE PITCHED TOWARD TRAP
TRAP TO BE INSTALLED BELOW DRAIN POINT IF POSSIBLE. IF NOT POSSIBLE, A CHECK VALVE MUST BE INSTALLED ON INLET SIDE OF TRAP
HEADER VALVE
BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP
MARK | MQR | MAT'L | DESCRIPTION
ST-1 | 1 | | ½" STEAM TRAP - ARMSTRONG #211
SS-1 | 1 | | ½" STRAINER - 250# W.S.P. -
V-4 | 2 | BRZ | ½" GATE VALVE SCRD - 200# W.S.P. -
V-20 | 1 | BRZ | ½" GLOBE VALVE SCRD - 200# W.S.P.
V-3 | 1 | BRZ | ½" GATE VALVE SCRD - 200# W.S.P. -
V-70 | 1 | BRZ | ½" CHECK VALVE SCRD - 200# W.S.P. -
E-4 | 2 | FRGD | ½" 90° SCRD ELL - 2000#
E-41 | 1 | | ½" 90° STREET ELL - 3000# -
U-4 | 2 | | ½" UNION - 2000#
N-1 | 1 | ST'L | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-3 | 1 | ST'L | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N-4 | 6 | ST'L | ½" SHORT NIPPLE - SCH 80 - SEAMLESS ASTM A-53
N 6/4 | 1 | ST'L | 6" x 4" LG NIPPLE - SCH 80 - SEAMLESS - ASTM A-53

Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8123 Maple St., Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS

Plant Electrical Fact File

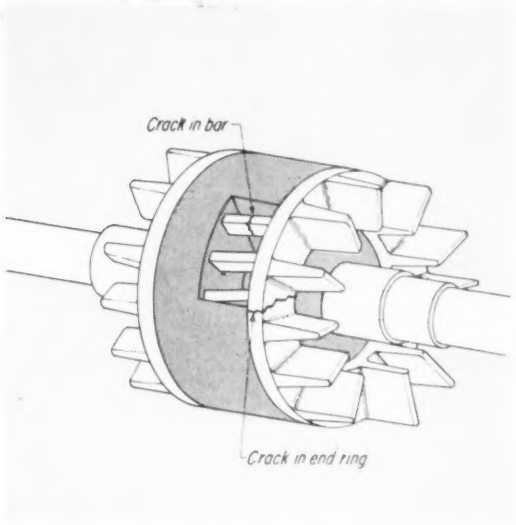
NO. 23: OPEN ROTORS

How to find open circuits in squirrel-cage rotors

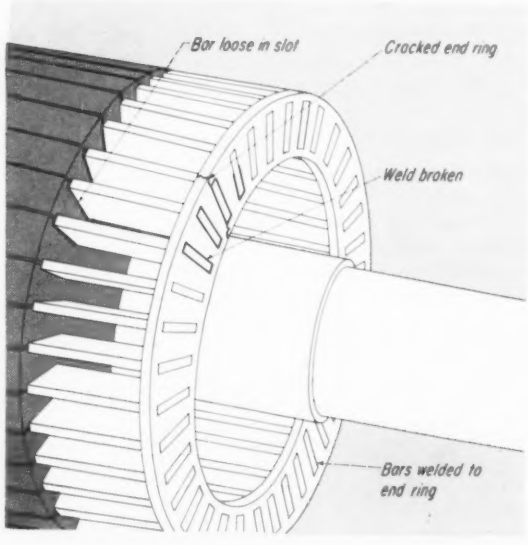
By NORMAN PEACH, Assistant Editor

Rotors of squirrel-cage induction motors are rugged and rarely give trouble. However, once in awhile an open circuit will occur in a rotor cage. Often it isn't immediately recognized as the cause of the motor's peculiar behavior. Unusual sounds—sometimes whistles, more often growls—and a loss of torque are indications. Or the motor may start reluctantly at times, or not at all, depending on the position of the rotor. First thought is to check the stator, but if windings are OK, and the core is rigid, clean and in its proper place, take a close look at the rotor cage.

Where to look for trouble

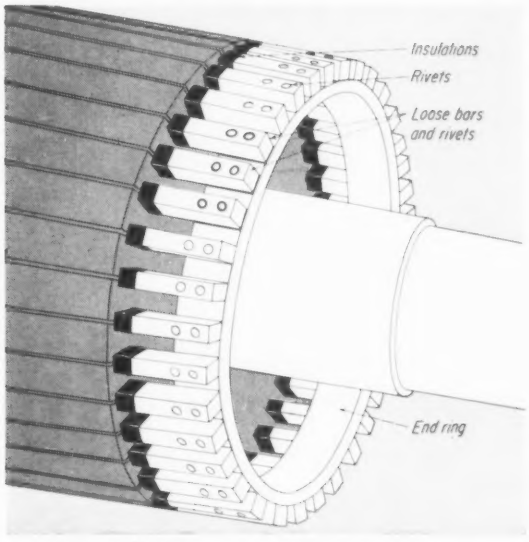


CAST ROTORS are usually made of aluminum alloy; some manufacturers have used bronze for special-purpose motors. Combined overheating and severe mechanical shock, or possible flaw, can cause a crack. Cracks in cast bars in slots can't be repaired; a skillful weldor can sometimes repair cracks in end ring, using electric arc and suitable aluminum-alloy.

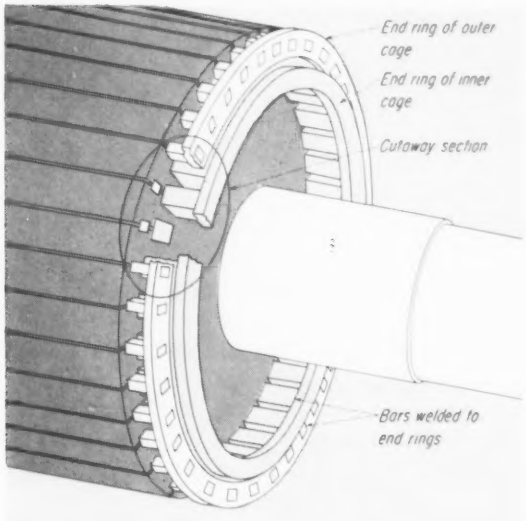


WELDED ROTORS are favored by some makers. They are better adapted for high-resistance and special-purpose rotors. End rings are usually close against core; rotor, above, has long bars to get added resistance, help cooling. This end ring is slotted; many are butt-welded, others are made of fused bar ends. Bars can be replaced, but use the same dimensions and alloy.

in different rotors

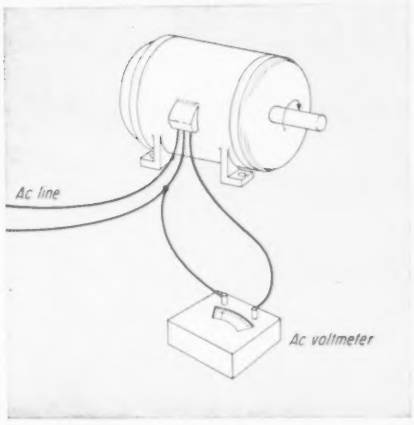


SOLDERED ROTORS aren't built any more, but many old-timers are still in service. Bars were riveted or screwed to end rings, then soldered. This construction is susceptible to trouble from overheating. If repairs are extensive it may pay to remove rivets, old solder and braze or silver-solder bars to end ring. Slot insulation was intended to reduce some of core losses.

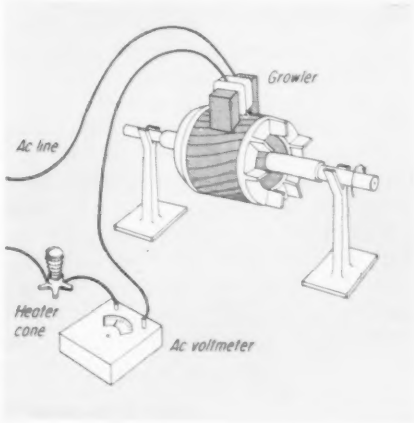


DOUBLE-CAGE ROTOR is designed for special starting characteristics. Outer cage has small-diameter, high-resistance alloy bars. It's most active during starting. When rotor gets up to speed, inner cage enters the picture. It has lower resistance, can handle load power continuously. Trouble is more likely to occur in outer cage. Tests won't tell which cage is bad.

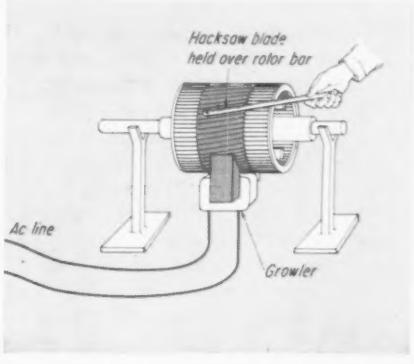
Three rotor tests



ON-THE-SPOT test can be made with voltmeter or test lamp. Energize one phase—with reduced voltage if necessary—rotate shaft slowly. Fluctuation means an open.



BENCH TEST uses growler (transformer primary), resistor, voltmeter or test lamp. Rotate rotor slowly, holding growler still. Voltage fluctuates when open is reached.



OPEN BAR can often be located using a hacksaw blade; attraction is weaker where bar is open. Growler induces voltage in solid bars; shift to find effective spot.

Basics . . . bringing engineering theory down to earth

NORMAN PEACH, Assistant Editor

Electricity: 19

What determines speed of motors?

Speed of induction motors and synchronous motors depends on frequency of power supply and on number of poles in the motor winding. Recalling how rotation is produced in the induction motor (February *Basics*), we can see how the magnetic poles advance around the stator, one-third pole every 60 deg or two poles every cycle. Thus higher the frequency, faster the poles will advance. In a 2-pole motor the magnetic field makes one full revolution every cycle; that is, 60 revolutions per second or 3600 revolutions per minute. In a 4-pole motor, however, the field makes only one-half revolution per cycle, or 1800 rpm. Speed of field is called the *synchronous speed;* it's found by this formula:

$$\text{synchronous rpm} = \frac{60 \times \text{frequency}}{\text{pairs of poles}} = \frac{60 \times 60}{\frac{1}{2}\ \text{poles}} = \frac{7200}{\text{poles}}$$

Frequencies other than 60 are rare in U.S.A. At 50 cycles synchronous rpm = 6000/poles.

Full-load speed is less than synchronous because of slip. Slip varies between 2 and 10% for squirrel-cage induction motors. Usual ratings are shown in table.

Dc motors can be designed for any speed; speed is not dependent on number of poles. For convenience, however, manufacturers have standardized speeds for general-purpose motors, table right. Dc motor is constructed substantially the same as dc generator (*Basics* No. 9), and speed can generally be *increased* by weakening field flux. There's a limit, however. Maximum speeds obtainable by this method at rated horsepower are shown for a 10-hp motor. Maximum speed varies somewhat with horsepower rating. Field strength is controlled by variable resistor, called a *rheostat.* Dc motors are well suited for adjustable-speed applications since speed can be gradually adjusted. Constant speed can be kept with varying load by an automatic rheostat.

Induction motors

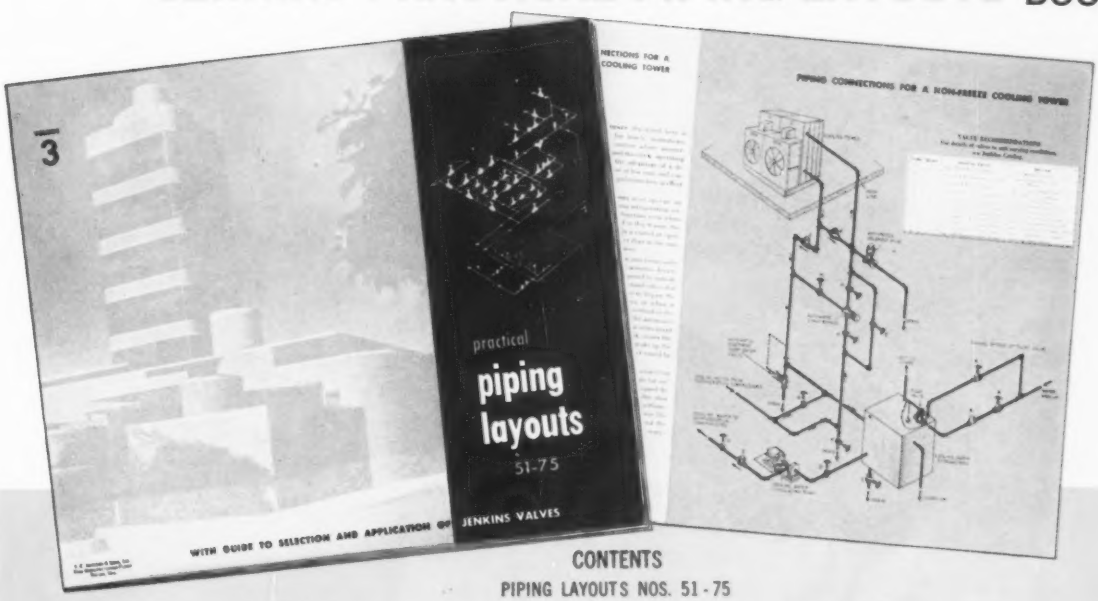
Number of poles	Synchronous speed, 60 cycles	Full-load speed
2	3600	3450
4	1800	1725
6	1200	1140
8	900	850
10	720	680
12	600	560

Direct-current motors

Full-load rated speed	Maximum speed (10-hp motor)
3500	3500
1750	2190
1150	1725
850	1700
690	1380
575	1150

AVAILABLE NOW! no. 3

in the famous series of JENKINS PRACTICAL PIPING LAYOUTS Books



CONTENTS

PIPING LAYOUTS NOS. 51 - 75

No.	PIPING LAYOUT
51	Storage and Vaporizer Hookup for Liquefied Petroleum Gas.
52	Package Boiler Connections
53	District Steam Building Connections
54	Steam Desuperheater Piping Connections
55	Dry Cleaning Solvent Distillation Piping Connections
56	Automatic Combustion Controls
57	Connections for Typical Meters
58	Piping Connections for Steam Turbine Driven Centrifugal Refrigeration Compressor
59	Absorption Refrigeration Piping for Air Conditioning System
60	Single Coil All-Year Air Conditioning System
61	Cooling Water System for Refrigeration Compressors
62	Zeolite (Base Exchange) Water Softening System
63	Piping Connections for a Diesel Engine Lubrication Oil Purification System
64	Piping for Plumbing and Heating in a Small Taxpayer Building
65	Piping Connections for an Industrial Plant Air Compressor
66	Piping Connections for an Air-Washer Air Conditioning System
67	Continuous Cold Lime-Soda Ash Water Softening System
68	High Pressure—High Temperature Hot Water Piping System
69	Steam Jet Refrigeration System
70	Industrial Waste Treatment System
71	Piping Connections for a Non-Freeze Cooling Tower
72	Sulfate Pulping Process System
73	Piping for Acid Liquor Preparation in the Sulfate Pulping Process
74	Sulfate Pulping Liquor Recovery System
75	Piping Connections for Space Heating with Refrigeration Condenser Hot Water Discharge

PLUS 10 PAGES OF VALVE SPECIFICATIONS

Volume 3 is a 36-page collection of 25 basic piping diagrams with complete recommendations for valve selection and location in the lines. The material has been prepared by registered consulting engineers in collaboration with the Jenkins Bros. engineering staff and leading equipment manufacturers. It supplements the two booklets released by Jenkins Bros. in past years as a service to consulting engineers, architects, contractors, specification writers and plant operation managers.

In addition to the piping diagrams, this book contains a ten-page, illustrated quick-reference specification "chart" which gives essential data on the complete line of Jenkins Valves.

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS SINCE 1864 Jenkins Bros.

Sold Through Leading Distributors Everywhere

For your copy, *please request Volume 3, Jenkins Practical Piping Layouts on your letterhead.*
Write to JENKINS BROS., *Room 41, 100 Park Ave., New York 17.*

"Hold on there, you brainless baboon!" Marmy yelled at him, grabbing his hand just in time. "Are you trying to burn her up?"

Marmy's dry boiler

One thing that makes an editor's job pleasant is having power engineers from all over the country drop in when they visit New York. Yesterday Miles Davis, who operates a large Syracuse, N. Y. plant, paid us a visit.

When he saw Marmaduke Surfaceblow's portrait above my desk, he stopped abruptly and said, "I've been reading Surfaceblow's yarns in POWER for years and I'd like to meet the old gent. The more I read about him the more I'm convinced I ran across him years ago in Michigan. I inspected boilers out there for an insurance firm."

"That's swell," I said. "Suppose we go around the corner to Bedlam's Bent Propeller Bar and have some lunch. Chances are the old boy will be sounding off about one of his unusual experiences." "Okay," agreed Davis, "that suits me just fine."

Stepping into Bedlam's is always an adventure. It's like visiting the crossroads of the world. You run into sea dogs from places like Montevideo, rubbing elbows with engineers from Murmansk. It's the United Nations of the seafaring world.

Sure enough, Marmaduke's gray bowler reigned supreme along the bar. He was facing the brightly polished bent propeller, his foot on the brass rail, in a characteristic pose. On either side of him were mariners of various sizes, shapes and colors, jabbering away in their native tongues and drinking a variety of concoctions from boilermakers to Singapore gin slings.

The checkered-cloth covered tables were almost all occuped and the sawdust on the floor had been well kicked around, indicating a brisk business.

We sidled over to our reserved table and asked Marmaduke to join us in a meal of kippered herring, rye bread and ripe olives. He accepted with his customary dignity, although I know he had been waiting for some sort of a windfall to come his way. He was never known to pass up a free lunch.

"Seems to me I ran across you in Michigan back in the twenties," began Miles, after we were seated. "I'm just wondering if you ever came across a character by the name of Windy Willis, who operated the Standard Furniture Co's boiler room in Grand Rapids. He was a tall, lanky bean pole about 6½-ft high—the tallest engineer I ever saw."

"Windy Willis?" mused Marmaduke. Then, to make the old gray matter percolate, he threw a stiff Sandpaper Gin gullet washer down the hatch and quickly closed it to keep the flareback from singeing his walrus mustache.

It worked. Light commenced to sizzle in through the dense fog. His eyes lighted up suddenly. Then his fist came down on the table with a crash that sent our drinks flying halfway up to the ceiling.

(*Continued on page* 184)

Forest of Facts on Nalco® RECIRCULATING WATER TREATMENT

NALCO Laboratories' continuous research program has gathered this forest of facts about protecting recirculating water systems. In the search for the most effective *and economical* formula, the metal rods shown have been rotated in all types of recirculating waters and treating chemicals. Results pointed the way to a group of Nalco Treatments which assure users against scale and corrosion in virtually any recirculating waters. For details on Nalco Treatment to fit your particular system, call your Nalco Representative, or write direct.

Test rod from water treated with the Nalco 82 Method shows protective film and freedom from any scaling or corrosive attack.

THE Nalco 82 METHOD MAY BE THE ANSWER FOR YOU

The Nalco 82 Method is particularly suitable for scale and corrosion control in recirculating water systems which fall within the characteristic limits given here. Check them to see if your system should have Nalco 82 Treatment:

- Equipment to be protected contains steel and/or brass.
- Hardness of makeup water is more than 50 ppm; and sulphates and chlorides, as sodium salts, are less than 150 ppm.
- Calcium hardness of makeup can be as much as 500 ppm.
- Silica content of makeup water up to 50 ppm.
- Total alkalinity of makeup more than 40 ppm.
- Recirculation rates between 100 and 100,000 g.p.m.
- Where non-toxic waste water is required.

Act today to get the certain, low-cost protection of The Nalco System. Full data on Nalco 82 in free Bulletin 68.

NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

THE Nalco SYSTEM . . . Serving Industry through Practical Applied Science

Reader service section

Start with these quick samples...

Did you know . . .

that automation is even speeding up production of that old bottleneck, the "special" motor? Our roving reporter fought his way through the year's heaviest blizzard—26 inches and piling up fast—to reach the Schenectady sector of the Tri-City area and check this new development. He beat the icicles off his briefcase, and came back with a story for . . .

Reports from the field, p 158

The Ides of March . . .

an unhappy time for Julius Caesar and for quite a lot of Americans, has made us more conscious than ever of our pocketbooks, so we've looked up a number of papers on cost-cutting in industrial plants. We have our eyeshades on and our pencils out, the midnight fuel is burning, and *next* year shall not catch us unawares!

Technical briefs, p 160

No humidity . . .

not with an industrial air dryer! This handy gadget removes water vapor from compressed air, prevents condensation in piping systems. And if that hot, corrosive dust has you down, our suggested solution is a filter made of glass, to operate at temperatures up to 600 F, resist deterioration from most corrosive substances . . .

Plant equipment news' p 164

A six-foot shelf . . .

or, at any rate, a 40-volume library, is lined up in our literature section for this month. From *A (Air conditioning, heating and ventilation)* to *V (Valves)*, we've rounded up some of the latest bulletins, and they're yours for the asking. *Boilers, Electrical equipment,* and *Nuclear energy* are some of the intermediary topics listed in . . .

Free literature, p 171

If Fido could speak . . .

what would he say? It's a pretty safe guess that he'd have mostly good things to say about us, but are we always careful in using our power of speech? Words have a tremendous potential force for doing good—or harm. Just a word or two can set off a chain reaction which will grow and grow, and may end—nobody knows where . . .

George Edwards, p 174

For other timely ideas, see following service pages▶

Burn COAL the MODERN WAY

with DETROIT STOKERS

SAVE!

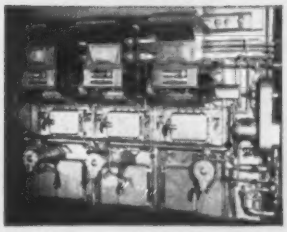
Coal is the economical fuel in most industrial areas. Safest to handle and store, its steady and continued supply is assured by huge reserves.

With a Detroit Stoker you can burn coal the modern way . . . saving 10% to 40% over other fuels.

Detroit Stokers are dependable, durable . . . last for decades. There is a type of Detroit Stoker to meet your needs.

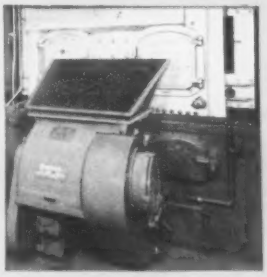
Let us show you the savings available. Recommendations by our engineers will cost you nothing.

DETROIT ROTOSTOKER



Spreader stoker. Economically burns all grades of Bituminous coal or Lignite. Power, hand dumping or stationary grate types.

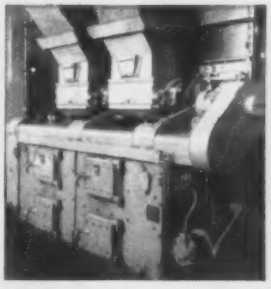
DETROIT LOSTOKER



Compact underfeed stoker for smaller boilers. Capacities 3,000 to 12,000 pounds steam per hour. Plunger feed, mechanically driven side cleaning. Coal feed and air supply may be automatically controlled.

DETROIT ROTOSTOKER—TYPE C-C

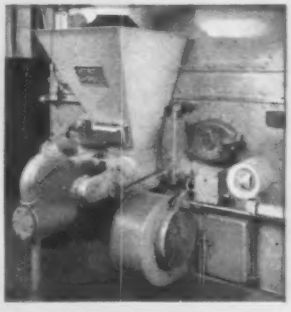
(Continuous Cleaning) Reciprocating grates that slowly discharge ash at front. Steaming capacities from approximately 5,000 to 75,000 pounds. Smokeless with wide load range.



DETROIT SINGLE RETORT STOKER

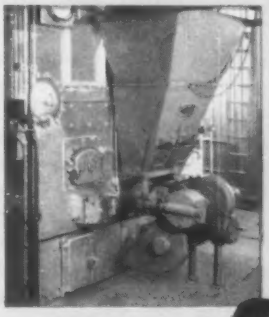
(Detroit UniStoker)

Side cleaning, underfeed stokers. Motor or turbine driven. Adjustable feed provides manual and automatic control. Capacity range 12,000 to 24,000 pounds steam per hour.



DETROIT ROTOGRATE STOKER

Spreader stoker for higher capacities up to 400,000 pounds. Forward moving grates that discharge ash at the front. Higher burning rates for longer periods. Heavy duty.



DETROIT DOUBLE RETORT STOKER

Side cleaning heavy duty underfeed stoker with two retorts, mechanically driven. Available for capacities from approximately 20,000 to 34,000 pounds steam per hour. Requires no basement.

DETROIT STOKER COMPANY

MAIN OFFICE AND WORKS • MONROE, MICHIGAN

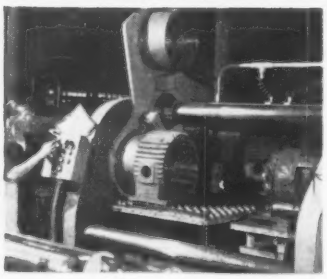
District Offices or Representatives in Principal Cities

DETROIT SINCE 1898 STOKERS

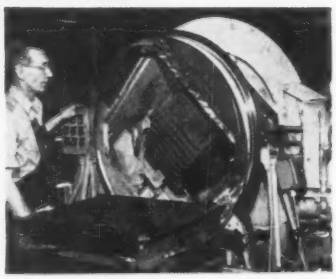
Reports from the field

What's happening in power and what it means to you

A PUNCHED TAPE (arrow) controls this automatic-jump statorcoil-winding machine



THIS MACHINE mates stator assemblies to frames under 25-ton pressure



DOWEL-DRILLING machine takes over next, rotates frame through 180 deg

Automation cuts motor-building time by 50%

One of the tough problems faced by industry today is delivery time for special motors. Long waits between order and delivery may induce purchasers to stockpile motors, producing large inventories and increasing the cyclic nature of the motor-manufacturing business.

When the General Electric Co took the wraps off their new Schenectady Small AC Motor and Generator Dept, they showed in tangible terms that automation can chop delivery time in half, with no corresponding increase in prices. A close approach to full automation features tape-controlled machines and processes for virtual "hands-off" manufacturing. The result is short-notice availability of most motors, including delivery of "specials" in four to six weeks and standards in two weeks, which should go far toward helping customers reduce their inventories.

Since less than 1/3 of all motors in 40-125 hp ratings are standard, design of new facilities was primarily aimed at speeding up manufacture of specials. Standardized components which could be assembled in (*Continued on page* 220)

Power lines

Check *Nuclear Notes*, p 86, for run-down of latest fusion facts; next month's issue for an expanded report on how this development may affect the power field today and tomorrow.

Once-through type variable-pressure generator will provide 1,638,000 lb of steam per hr at 2400 psi, 1050 F; reheat steam to 1000 F. Unit will be built for Southern California Edison Co by Babcock & Wilcox Co.

Molybdenum can be utilized at working temperatures over 2000 F as a result of a new surface-alloying technique. Treatment reportedly provides a high degree of oxidation resistance: 400 hours at 2000 F.

Japanese industry paid $42,778,000 in royalties for foreign technical and patent rights last year; has become one of the fastest-growing markets for industrial know-how in the world.

Soviet scientists are speculating on a scheme to dam the Behring Straits, pump in warm Atlantic water to melt Arctic icecap. Result might be a 10 C air-temperature rise for New York.

Another boom year of "scientist-engineer ascendancy" is forecast by Witty Consultants. Search for engineers should be even more intensive than last year, result will be "hoarding."

Heat pump has now been designed to heat commercial and industrial buildings in ambient temperatures of as low as –20 F.

For Calendar of Events see page 222

No Excessive Heating

New Rectifier Cooling System Prevents Heat Build-up and Damage

when ac Power Fails

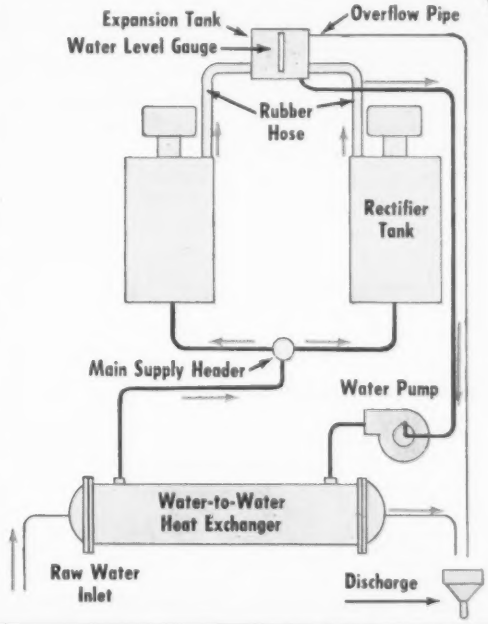
A SAFER, more effective cooling system in the Allis-Chalmers rectifier continues to circulate water *even when an ac power failure stops the water pump.* Heat and steam are dissipated before they can develop to the danger point.

The new system features an expansion tank that extends the full length of the rectifier frame with short vertical connections from each tube. With warm water continuing to flow freely upward, a thermo-siphoning action draws cooler water into the tubes. Build-up of excessive temperatures is prevented. Steam pockets are kept from forming. Subsequent water loss from the recirculating cooling system is minimized.

Successful operation in hundreds of installations is your assurance of the complete reliability of Allis-Chalmers mercury arc rectifiers. Contact your nearby A-C office or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wis.

How the System Works

Water is normally pumped through the water-to-water heat exchanger to the main supply header from where it circulates through rectifier tubes picking up heat. Hot water flows up through the short connections to expansion tank and back down to suction side of water pump.



ALLIS-CHALMERS
Mercury Arc Rectifiers

Factory-packaged units cut installation time and costs. Sealed tube rectifiers are supplied in completely enclosed or open types. Here is a typical, completely enclosed, 1000-kw, 250-volt rectifier for steel mill service.

ALLIS-CHALMERS

A-5425

Technical briefs

Latest engineering developments for busy power men

14 papers for you on:

COSTS
FUELS, FIRING
TESTING

Boiler plant operating and maintenance costs

	Coal-fired		Coal-dual		Fuel oil		Gas
	Modern	Other	Modern	Other	Modern	Other	Modern
Cents per 1000 kwhr generated							
No. of stations	43	49	7	13	6	6	3
Boiler labor	10.1	33.9	11.1	42.5	17.1	30.8	15.4
Maintenance, coal & ash handling	5.7	10.3	2.9	11.2	0	0	0
Maintenance, furnace & boiler	4.3	15.1	2.7	21.8	2.3	15.5	1.0
Totals	20.1	59.3	16.7	75.5	19.4	46.3	16.4
Cents per ton of coal or ton of coal equivalent							
Boiler labor	22.6	58.3	22.5	73.4	37.5	56.2	31.0
Maintenance, coal & ash handling	12.7	17.8	6.7	20.1	0	0	0
Maintenance, furnace & boiler	9.3	30.2	6.5	37.3	6.7	25.9	1.5
Totals	44.6	106.3	35.7	130.8	44.2	82.1	32.5

Coal-burning stations cut costs

Incremental cost of burning coal in utility generating stations. *By H B Lammers, Appalachian Coals, Inc*

The author analyzes approximately 200 utility generating stations to determine operating and maintenance costs as related to generation, coal consumption and coal quality. He then discusses and evaluates the incremental cost factors involved in burning coal.

As table, above, shows, operating and maintenance costs for the boiler plant have been reduced considerably for modern stations (placed in service since 1950) as compared with other stations (placed in service prior to 1950). For the coal-fired station, and for the accounts listed, cost reductions amount to 39.2 cents per 1000 kwhr; 61.7 cents per ton of coal consumed. This is in spite of the fact that "other" stations frequently use both the old and the modern in equipment.

The author concludes that while considerable progress has been made in reducing operating and maintenance costs in the boiler plant, still further economies can be effected by (1) using quality coal (2) increasing the station capacity (3) adding to investment to increase automation (4) operating at high load factors.

Performance should be the basis for coal selection; comparative fuel costs should include the incremental costs of coal burning if a true index of a coal's value is to be determined.

As a basis for comparison, the unit cost should be reported per 1000 lb of steam generated and at standard conditions or per net kwhr output. *ASME paper, No. 57-A-187*

Application of bonus-penalty method to coals being purchased or evaluated. *By R M Schahfer, and F H Strout, Northern Indiana Public Service Co, and G W Land, Truax-Traer Coal Co*

A coal's true value to the consumer increases with increased Btu per pound and decreases with increased amounts of moisture, ash and sulfur present in the coal. Handling charges within the plant, including power costs and maintenance, heat losses in the boiler or steam generator, and power replacement costs resulting from decreased boiler availability or capacity are items that must be considered in determining the relative or true value of coal.

The authors have devised a method for correcting the price to be paid for coal to adjust for receiving coal with lower or better quality than that guaranteed in the purchase contract. Application of such adjustments to the price of coal maintains a constant net cost of coal purchased. Application of such adjustments in the comparison of coals offered by bidding suppliers places the evaluation of competing coals on a rational basis.

Quality of coal received by the author's company has increased in the four years they have been using the bonus-penalty method, and the average Btu per pound of coal received last year was the highest in company history. *ASME paper, No. 57-A-115*

Costs

Planning and scheduling for effective maintenance cost control. *By S Whitehead, American Cyanamid Co*

To meet the increased demand from keen competition, analyze carefully the contribution that maintenance is making to the cost of each product manufactured. A substantial contribution can be made by improving the effectiveness of planning and scheduling in the maintenance department.

By analyzing and planning the workload over a year, encouraging the trends toward more long-range work and more routine work, by adjusting and simplifying your manpower requirements, and by proper scheduling of the workload, efficiencies will be effected. Next, by evaluating accurately the effect of the department's expenses in the overall cost of manufacturing, it will be possible to appreciably reduce maintenance cost.

The integration of these elements of planning and scheduling in the

. . . for heavy fluids, steam, water and gas . . . *it's J-M Jewett*®

Strong, tough Jewett has been proven the ideal packing for heavy duty valve stem service against crude and heavy oils, tar, molasses and other heavy gummy fluids. It also provides efficient sealing against steam; fresh or salt, hot or cold water; air; gas and some chemicals requiring a packing free from rubber.

The basis of Jewett's exceptional durability is its construction of high-quality long fibre asbestos yarn with fine copper wire inserts. This yarn is braided over a lead ribbon core and formed square. Style 10 is treated with a heavy bodied, heat-resisting lubricant which won't bleed in valve stem service. Furnished graphited in coil or ring form in sizes from ⅛″ up.

. . . for superheated steam and gases to 1200F *it's J-M High Temperature*

When valves are operating in high temperature service, your best packing choice is Johns-Manville High Temperature Style 397. It retains its resilience, holds a tight, lasting seal against superheated steam and dry gases under elevated pressures and temperatures up to 1200F.

To obtain this high sealing efficiency, Johns-Manville braids asbestos yarn of high purity over a plastic core of special heat resistant composition. For extra strength, the yarn is reinforced with tough heat and corrosion resistant Inconel wire. The packing is formed square and then lubricated with graphite. Furnished in ring, coil and spiral form in sizes ¼″ to 1″.

Your local J-M distributor carries full stocks of Jewett, High Temperature and other packings. Call him today or write Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario.

Johns-Manville PACKINGS, GASKETS and TEXTILES

More **technical briefs**

Begins on page 160

basic maintenance objective will be lower maintenance cost per unit of product produced, the final objective. *ASME paper, No. 57-A-288*

Economics of heating and power systems for large industrial plants. *By W T Batcheller, Seattle, Wash.*

It is often practicable to generate high-pressure and high-temperature steam for combined process, heating and electric power purposes. Noncondensing and automatic extraction condensing steam turbines serve as pressure-reducing valves, and the exhaust or intermediate-stage bleed steam is fed into the steam mains supplying the industrial plants. Total cost of steam generation is then divided in proportion to respective heat consumptions between heating and process steam and power requirements. This combined use of steam is highly economical.

But economies have been greatly enhanced by adding another feature in connection with coal-fired thermal generating plants. This is particularly effective adjacent to desposits or mines producing high-volatile semi- and sub-bituminous and lignite coals, normally classified as low grade but actually richest in by-product producing volatiles. This feature is washing, drying and processing these coals to remove free ash and to recover, separate and refine the volatile tars and oils, and convert them into a wide variety of finished products immediately usable by chemical, plastic, paint and drug industries, and as aviation-gasoline additives. Revenue realized from the sale of these byproducts is then applied as a credit on the fuel, steam and power costs.

This paper gives technical, capital cost and production cost—accounting data along with effects of credit from sale of byproducts in varying amounts after providing fuel requirements for any given industry. *ASME paper, No. 57-A-123*

Economic choice of generator unit size. *By L K Kirchmayer and A G Mellor, General Electric Co*

This paper presents a method of analysis for the economic choice of generator unit size based on probability mathematics. The application of this method to a study of an assumed single integrated system is given, as well as a study of two interconnected areas. *ASME paper, No. 57-A-154*

Fuels and firing

Effects of particle size on firing pulverized solid fuels in boilers. *By A L Bayles, Allison L Bayles & Associates*

This paper contains a discussion of the process of firing pulverized solid fuels in steam boilers, some of the problems attendant thereto, and the probable effects of control of particle size of the fuel on them. It supports the idea that control of top size of solid fuel particles would contribute relief from some of the vexing attributes of solid fuel combustion, and can be attained within the range of economic possibility. *ASME paper, No. 57-A-276*

Directions for ordering papers on page 244

Steam from byproduct fuels. *By J B Walker, Jr, The Babcock & Wilcox Co*

This paper reviews briefly the past, present, and predicted future status of byproduct fuels which are practicable for use in steam generation. Their characteristics which influence handling and firing are discussed together with their overall effect on design of steam-generating unit. Examples are given of methods and techniques of handling these fuels, and operating problems encountered.

The author concludes that many industrial processes can be made to yield a greater return by efficient use of thermal energy sources they produce. With improved methods of conservation of natural resources, such use may become standard practice.

Attempts to apply standard types of boiler units not designed for the specific purpose can result in failure; as can units designed by one not having full knowledge of tne cycle in which it is to operate. Close cooperation between operator of industrial process and boiler manufacturer can result in steam-generating units that are economical and free from operating problems. *ASME paper, No. 57-A-126*

Steam from byproduct industrial gases. *By F G Raynor, The Babcock & Wilcox Co*

The design of a steam generator for the utilization of heat energy in byproduct industrial gases requires special consideration to the specific needs of the process involved and to the nature of the waste gas. A waste-heat boiler converts heat energy in waste gases to useful steam for process or power requirements. Various types of waste-heat boilers have been designed for specific needs as in the production of steel, copper, zinc and cement as well as for heat recovery from the exhaust gases from diesel engines and gas turbines.

Factors influencing design of the boiler to achieve optimum performance as well as recovery of process materials entrained in the waste gases are discussed. Typical waste-heat boiler installations are described together with factors effecting their design, including performance data of the operating units. *ASME paper, No. 57-A-194*

Development and operating experience of the jet-injection stoker. *By N W Young, The Babcock & Wilcox Co*

Industry has been continually searching for new and better ways to burn coal. Operating problems involved in small industrial or heating applications are not the same as those for large industrial or central-station practice. Stokers are often the only practical solution to the fuel-burning problems for steam capacities up to 200,000 lb per hr.

This paper briefly reviews the past history of stoker applications and describes the recently developed "jet-ignition" stoker. Performance data of the new equipment as related to various bituminous coals is discussed. *ASME paper, No. 57-A-192*

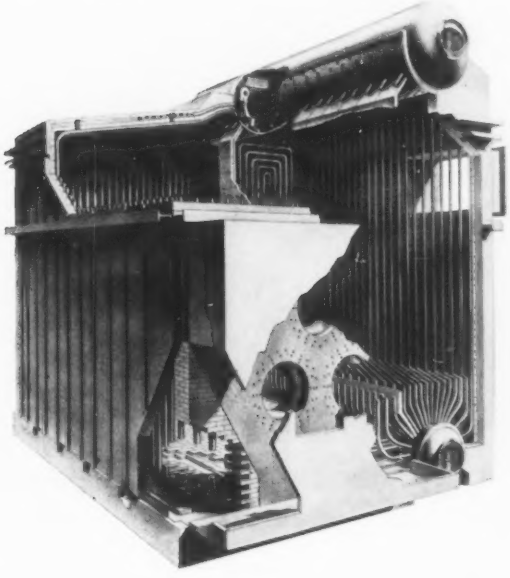
(*More Technical Briefs on p* 240)

Here's why you get

IMPORTANT SAVINGS in

- ✓ *first cost*
- ✓ *installation*
- ✓ *operation*
- ✓ *maintenance*

with the FW Series "SC" STANDARD BOILER

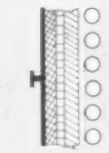


THESE nine Foster Wheeler design features add up to substantial savings in the cost of steam generation. Equally important is the extra *dependability* that's built into every "SC" unit – the result of over 60 years of experience in the design and construction of large, high-pressure steam generators for leading central station power plants.

Pre-engineered in all details and standardized for economy, these FW standard steam generators are available for oil or gas firing, in capacities from 50,000 to 150,000 lb/hr, for pressures to 1500 psi and superheated steam temperatures to 950 F. For complete information, send for Bulletin B-55-4. *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N.Y.*

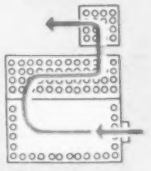
1. COMPLETELY WATER-COOLED WALLS

All furnace walls are cooled by closely-spaced tubes, minimizing setting maintenance and preventing excessive exit gas temperatures.



2. EFFICIENT FIRING ARRANGEMENT

Burner arrangement assures maximum rating without overheating furnace tubes. Rear wall is over 19 ft. from burner wall, permitting long, horizontal flame travel.



3. FULLY DRAINABLE SUPERHEATER

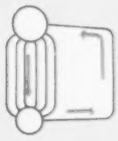
A completely drainable superheater permits removal of all condensed water from the elements before start-up.

4. HIGH STEAM PURITY

The normal drum internals consist of chevron dryers and a dry box. Separators may be added which make possible a steam purity of 1PPM or less.

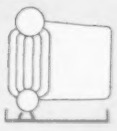
5. UNRESTRICTED CIRCULATION

Absence of headers provides free circulation through integral risers and downcomers, eliminating header handhole plates and gaskets.



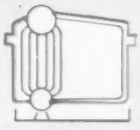
6. BOTTOM SUPPORTED UNIT

The bottom-supported design fully utilizes the structural strength of the tubes and provides low unit stresses in all members.



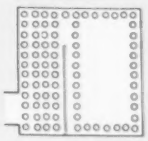
7. PRESSURE-TIGHT CASING

The all-welded casing forms a rigid, pressure-tight unit that can be arranged for pressurized or balanced draft operation.



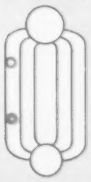
8. MINIMUM REFRACTORY BAFFLING

The wall separating furnace and boiler bank is the only refractory baffling used. It is completely accessible from the furnace.



9. SIMPLE SOOT BLOWER ARRANGEMENT

Soot blowers are supported on the outer row of boiler-bank tubes, simplifying alignment and providing easy access.



FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

Plant equipment news

Your information center for new products and materials

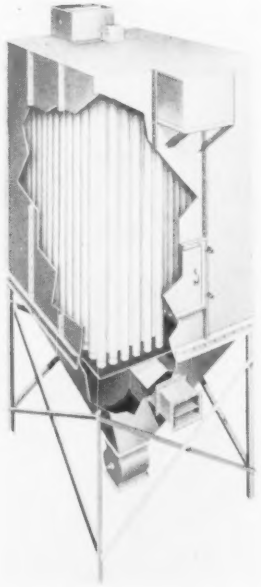
Air dryer eases piping maintenance

301 • Industrial air dryer removes water vapor from compressed air to eliminate condensation of water in piping systems. Designed for continuous operation, unit is shop-assembled on an integral structural-steel base, with all piping and controls self-contained.

Dryer is self-powered by compressed air. A reciprocating pump is the only moving part, and a daily check by operator is said to be sufficient maintenance. Unit is installed immediately downstream from air receiver. Saturated wet air from the compressor is brought into intimate contact with triethylene glycol. Water vapor is absorbed from air by the glycol, then removed by distillation.

Normal pressure rating is 125 psi. Dewpoint is lowered 40 F below temperature of air entering dryer, according to the manufacturer. Air dryer comes in standard sizes from 500 to 15,000 cfm. Manufacturer is T Melsheimer Co; additional information from distributor, *G W Leseman & Co, 2325 Torrance Blvd, Box 386, Torrance, Calif.*

For more data on these items, use post cards on page 171. Identify your request with item number



Glass-bag filter handles hot, corrosive dust

302 • Glass cloth combines maximum collection efficiency of cloth, temperature and corrosion resistance of glass, according to manufacturer. Glass cloth is said to permit filter to operate at temperatures to 600 F, resist deterioration from all corrosive substances except fluorine and hydrofluoric acid.

Housing is said to take maximum advantage of cloth filtration, yet prolong bag life. Filter bags are single-hung tubular type, made of fibrous-glass cloth treated for protection against fracture. Spacing between bags prevents contact during shaking. Bag suspension and shaking mechanisms were redesigned to assure correct bag-hanging tension, minimum wear and effective shaking, according to manufacturer.

Unit draws dust- and fume-laden air into hopper and upwards into bags. Cloth traps particles, allowing only clean air—99½ to 100% free of visible dust, maker claims—to pass through. — *Dracco Corp, 4063 E 116th St, Cleveland 5, Ohio.*

Crane Stop-Checks Mean Safer Boiler Operation

This valve cost-free for quarter century

Gate, globe, angle or stop-check—Crane steel valves are hard to beat for low-cost service on steam.

This is proved again on the installation at Scott Paper Company's West Coast Division at Everett, Wash. This Crane 300-pound stop-check has been on one of its boilers since the pulp mill was built in 1929. Working pressure: 250 psi at 450 deg. F.

Not until 1954 did this Crane No. 30XU valve need any repairs—after 25 years of steady operation with just routine maintenance. Now with new parts, it's ready to set another such record.

A single moving part: the disc—with chatter-free throttling lip—and effective disc cushioning—is one of the many reasons why Crane stop-checks have racked up this kind of service record in installation after installation. Ask your Crane Representative for full details, or write to address below.

IDEAS FOR YOU in this free book of "Valve Performance Facts." Your Crane Man has a copy for you.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

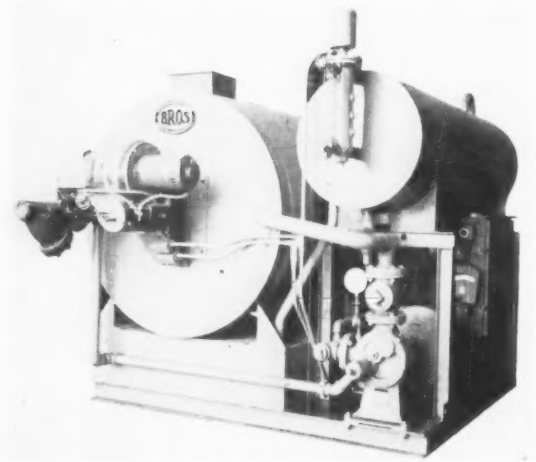
Since 1855—Crane Co., General Offices: Chicago 5, Ill.—Branches and Wholesalers Serving All Areas

Hard-surfacing welder is portable

303 • Wire-feed welder is designed for semiautomatic open-arc hard surfacing; uses 7/64-in. hard-surfacing wire. Unit can resurface most equipment parts subject to abrasion, impact or compression.

Welder is said to give quick, easy setup, fast wire changeover and great portability. Unit weighs 70 pounds, making job-to-job transfer a one-man operation. Wire supply is packaged separately; drawn directly from package, so there are no wire coils to untie and retie when changing wire. Threading wire through welder is also easier, manufacturer states. Unit will operate from most dc power sources, and only two electrical connections are required.

Feature is said to be set of straightening rolls located just ahead of double-knurled feed rolls. Wire is straightened before entering feed cable, which allows it to feed more easily, prevents oscillation as it comes out of the welding tip, according to manufacturer.—*Alloy Rods Co, Box 1828, York, Pa.*

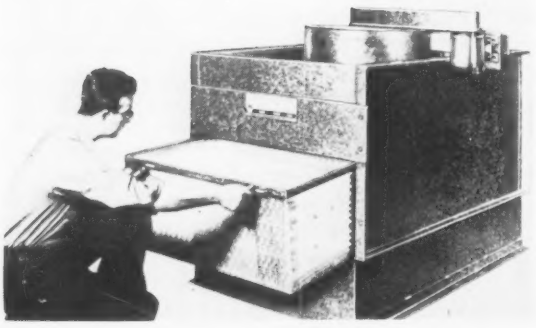


Oil heater generates 500 F

304 • Automatic oil heater generates temperatures to 500 F, operates at pressures below 15 psi. Unit is said to produce exact quantities of heat automatically. All-electric control system is mounted in a centralized, completely weatherproofed control box. Electrical system contains performance controls, safety controls such as a flame-failure control, a low oil-level control, and an extreme-temperature control, manufacturer states.

Heaters burn light oil, heavy oil, gas or a combination. Five models are available with outputs of 1,050,000 to 3,650,000 Btu per hr.

Applications include warming large tanks of viscous materials, compounding lubricants, plastics molding and extruding organic synthesis.—*Bros Incorporated, 1057 Tenth Ave, S E, Minneapolis 14, Minn.*



Compact cooling tower saves space

305 • Low-silhouette general-purpose cooling tower has 15- to 200-gpm capacity, is 44- to 84-in. high. Tower's compactness was made possible by use of multifinned internal decking constructed of noncorrosive plastic, manufacturer states. Notched plastic sheets are said to provide four times more water-to-air exposure than conventional towers.

Internal decking units are removable for cleaning and inspection. All metal parts are hot-dip galvanized, providing a thickness 20% heavier than ASTM specs require, manufacturer claims.—*Binks Manufacturing Co, 3122 W Carroll Ave, Chicago 12, Ill.*

For more data on these items, use the post cards on page 171. Identify your request with item number

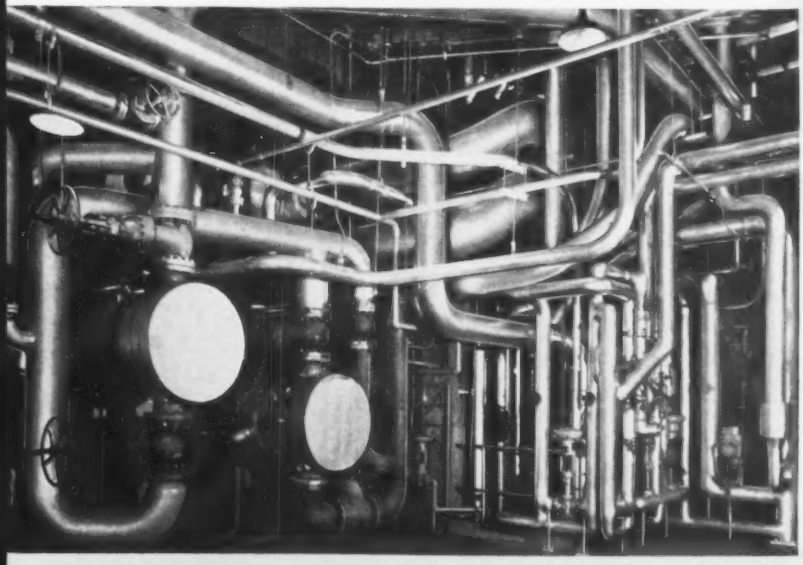
He's Looking For MONEY

This Midwest Piping Engineer is going over the customer's piping drawings in the light of his long experience in shop fabrication and field erection. He's looking for ways of doing a piping construction job better and at less cost.

Before a construction job is placed in the Midwest shops for fabrication, experienced engineers prepare Field Erection Sketches dividing each line into a series of subassemblies. These Sketches minimize and simplify the field welding . . . the difficult work is done in our well-equipped shops. They also disclose any discrepancies before fabrication instead of during erection. All erection planning has been done by our engineering staff . . . which reduces field thinking and eliminates guesswork. Erection is from these sketches instead of from the design engineers drawings . . . this speeds up the work and results in a real cost saving and earlier completion of the job.

The next time you have a piping job, you'll find it profitable to call in Midwest.

Midwest Piping at Kyger Creek plant which has a capacity of 1,075,000 kw and is the largest power plant piping contract (combining fabrication and erection) ever performed by a single contractor.



774

MIDWEST PIPING COMPANY, INC.

Main Office: St. Louis 3, Missouri (P.O. Box 433)
PLANTS: ST. LOUIS, CLIFTON, N. J. and LOS ANGELES

SALES OFFICES:

Asheville (Box 446, Skyland, N. C.) • Boston 27—426 First St. Chicago 3—79 West Monroe St. • Cleveland 14—616 St. Clair Ave. Houston 2—1213 Capitol Ave. • Los Angeles 33—520 Anderson St. Miami 34—2103 Le Jeune Rd. • New York 7—50 Church St. Pittsburgh 19, Pa.—437 Grant St. • St. Louis 4—1450 S. Second St. San Francisco 11—420 Market St.

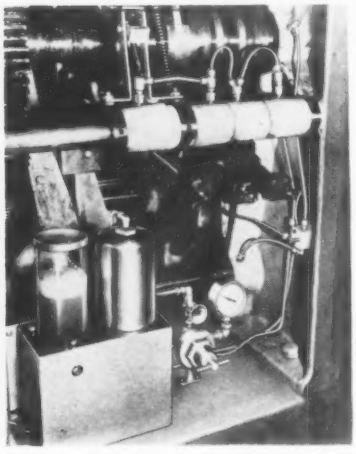
MIDWEST ... PIPING FABRICATORS AND CONTRACTORS FOR MORE THAN 50 YEARS

Gadgets simplify gasket cutting

306 • Dovetail designer is placed on gasket flange, used as pattern in outlining exact design. Centering line on various dovetails is said to assure accurate use on any width gasket flange. Unit is lightweight phenolic with nonslip gripping points.

A companion gadget is the bolt-hole locator. This unit is placed over a pivot pin in the center of a gasket. Equally spaced notched measurements accurately determine center point of bolt holes, regardless of number of holes or size of gasket, maker claims. *—Zimmerman Packing Co, Cincinnati, Ohio.*

Centralized lube system needs little space



307 • Low-pressure positive-displacement miniature lubrication system is for use on machinery with numerous bearings, limited installation space. Centralized system is said to efficiently lubricate industrial vehicles and machinery such as production, high-precision, "bottleneck" and "24-hour" machines.

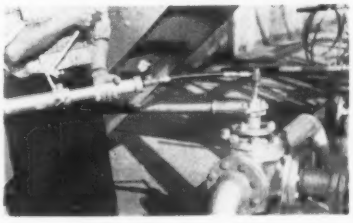
Miniature metering valve, slightly larger than a lube fitting, services each bearing individually, delivers specified amount of lube to each bearing in system, eliminates lube drainage from system when machine is idle.*—Alemite div of Stewart-Warner Corp, Chicago 14, Ill.*

Extreme-temperature lube takes 600-F service

308 • Developed to meet today's high-speed high-temperature lubrication requirements, new grease has an operating range of –45 to 600 F at speeds up to 30,000 rpm.

Designated grades *ETR Grease B* and *ETR Grease D*, lube has been field-tested by several bearing and engine manufacturers, and meets most present requirements for extreme high-temperature lubrication of rolling-contact bearings, maker claims. In a test rig operating at 10,000 rpm, grease is said to have performed satisfactorily for 1181 hours at 450 F, 162 hours at 600 F.

Development involved reappraisal of gelling agents and oils, maker claims, since conventional soaps and mineral oils tend to melt and run out at high temperatures, leaving metal parts without lube. A silicone fluid was found to have required volatility, oxidation stability and viscosity-temperature characteristics. Vat dyes proved most stable thickeners.*—Shell Oil Co, 50 W 50th St, New York 20, N. Y.*



Hydraulic handgun speeds valve lubrication

309 • High-pressure hydraulic gun is designed for plug-valve lubrication. Said to be both light and rugged, *Model 400-C* is self-priming, can be used in any position, according to manufacturer.

Hose and coupler can be locked to buttonhead fitting in valve shank. For protection, pressure may be relieved by a turn of the by-pass valve on the gun, permitting separation of buttonhead coupler and fitting, maker claims.*—Rockwell Mfg Co, 400 N Lexington Ave, Pittsburgh 8, Pa.*

Portable air tools now have noiseless exhaust

310 • Initial models of series, said to have noiseless, blastless exhaust, are light-, medium-duty drills, screwdrivers and tappers. Eventually entire air-tool line will incorporate noiseless-exhaust feature.

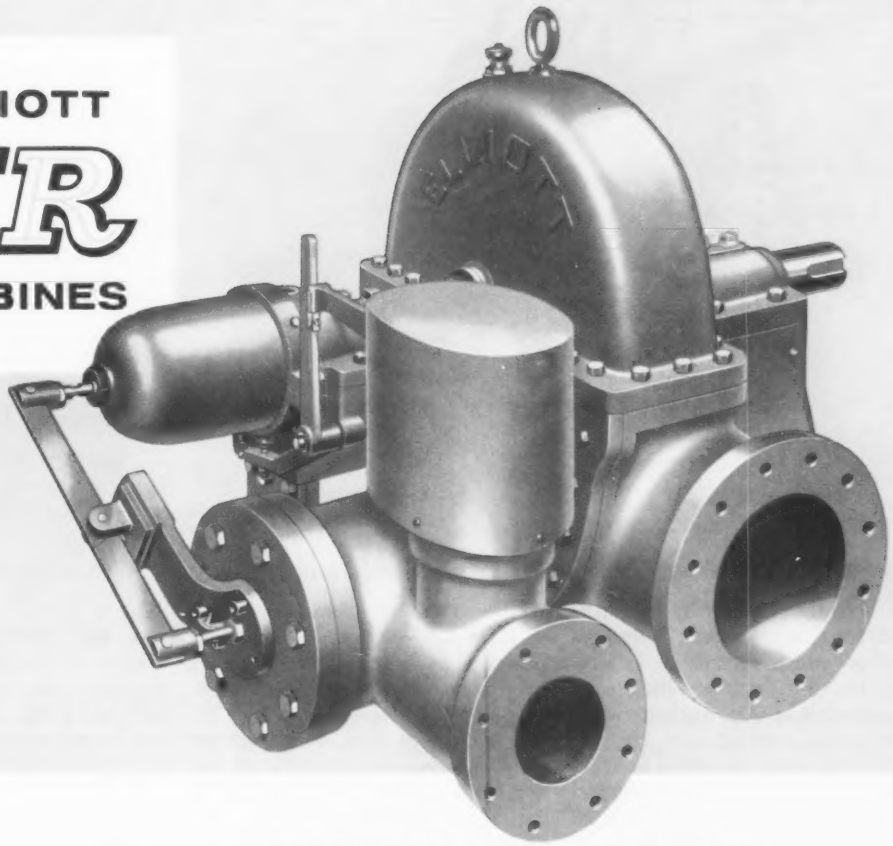
Quiet, smooth exhaust is produced by routing exhaust air back through a system parallel to the inlet system, so that it escapes at a point adjacent to air inlet. A porous bronze diffuser, located at the outlet, deadens any remaining noise and dissipates the escaping air evenly in all directions, according to maker.*—Aro Equipment Corp, Bryan, Ohio.*

For more data on these items, use the post cards on page 171. Identify your request with item number

ELLIOTT

YR

TURBINES

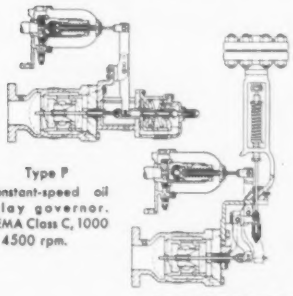


simplified design includes reliable governing system

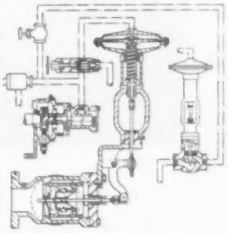
The Elliott-engineered, direct-acting governing system with overspeed trip and valve (NEMA Class A) positively insures smooth uniform speed 24-hours-a-day, day-after-day, year-after-year. The horizontal, fly-ball-type, speed-sensitive element is effectively weather-proofed by an aluminum enclosure . . . mounted on the end of the turbine shaft and directly connected to the steam admission valve by a sturdy linkage. Mica-impregnated packing and a flexible, non-aging Neoprene grommet insure an effective steam seal over long operating periods.

Other design benefits of Elliott single-stage turbines are easy inspection . . . simple replacement of wearing parts . . . and interchangeable components from one turbine frame to another. And always near you is your Elliott field engineer. For full details write Elliott Company, Steam Turbine Department, Jeannette, Pa. Ask for Bulletin H-22B.

YOUR CHOICE OF DESIGN MODIFICATIONS TO MATCH YOUR SPECIFIC APPLICATION REQUIREMENTS



Type P
Constant-speed oil relay governor. NEMA Class C, 1000 to 4500 rpm.



Type F
Built-in constant or differential pressure pump governor—to 4500 rpm.

Type O
Variable-speed oil orifice governor. NEMA Class A, 800 to 10,000 rpm.

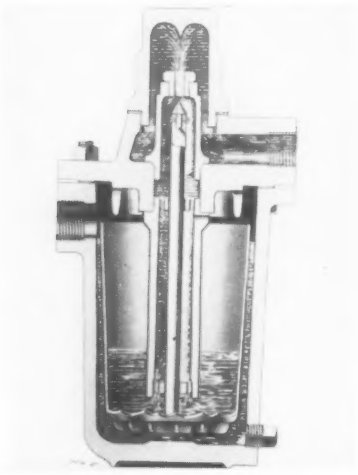
Other modifications include electric and pneumatic remote trip, high back-pressure trip, electric and pneumatic speed changer, low oil pressure trip, special shaft extensions, and various accessories.

TURBINES FOR DEPENDABLE day-in/day-out SERVICE

ELLIOTT Company

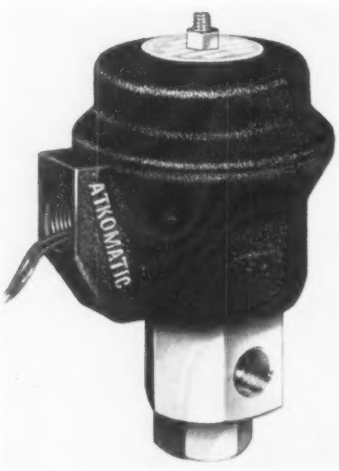
H8-1

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS



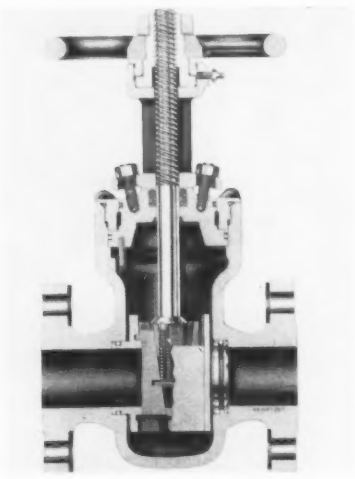
Rotating-valve steam trap

311 • Only moving part in trap is valve assembly — bucket, valve and impeller—which operates as integral unit. Impeller changes seating position of valve at each discharge, prevents uneven wear of valve and orifice, wire-drawing and steam leakage, according to manufacturer. Removable cap is said to ease maintenance. *—H O Trerice Co, 1420 W Lafayette Blvd, Detroit 16, Mich.*



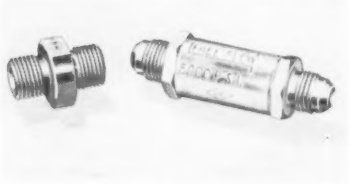
Two-way solenoid valve

312 • Two-way stainless-steel unit is rated to 6000 psi for control of corrosive fluids and gases. Direct-lift valve is machined from 316 stainless-steel bar stock; comes in ⅛-, ¼, ⅜- and ½-in. pipe sizes. Port sizes depend on pressures, viscosity of medium. Explosionproof housing is optional.*—Atkomatic Valve Co, Inc, 545 W Abbott St, Indianapolis 25, Ind.*



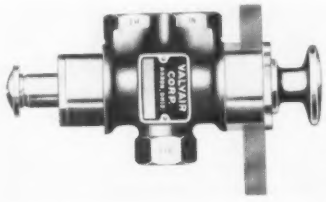
Nonlubricated valve

313 • Optional-flow, double block and bleed full-opening unit is designed to handle gases, petroleum products. Unit is said to eliminate galling or wear at seating surfaces, insure against product contamination by a vapor-tight seal. It comes in carbon steel, flanged ends, 2- through 6 - in. sizes. *Series 150, 300 ASA Standards.—Kerotest Mfg Co, 2525 Liberty Ave, Pittsburgh 22, Pa.*



Miniature check valve

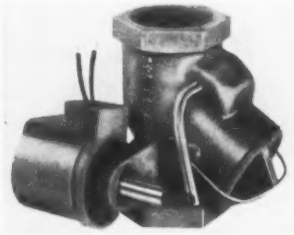
314 • Miniature valve for compact installations, left, is said to be no wider, only slightly longer than unions of the same tube size. Unit is made of stainless steel, operates on pressures up to 5000 psi, temperatures of –65 to +400 F. There are no seals or packings, which is said to eliminate leaking and maintenance.— *Republic Mfg Co, 15655 Brookpark Rd, Cleveland 11, Ohio.*



Knob-controlled valve

315 • Panel-mounted unit for up to 200-psi pneumatic and hydraulic or vacuum service has one-piece bronze body, is said to feature leak-free construction, unrestricted flow capacity, simplified mounting. Straight-through construction permitting drop-in replacement of packers simplifies maintenance, maker claims. *—Valvair Corp, 454 Morgan Ave, Akron 11, Ohio.*

Don't miss this item . . .



Solenoid drain valve . . . . . p 180

. . . or other product news appearing on following pages

Lapping machine . . . . . p 176
Teflon clipper seals . . . . . p 178
Slurry feeder . . . . . p 178
Storage-tank protection . . p 180
Combustible gas alarm . . . p 182
Complete pH package . . . p 182
Hygrothermograph . . . . . p 183

For more data on these items, use the post cards on page 171. Identify your request with item number

Keep yourself up to date . . .

To get more info on new equipment or FREE copies of latest bulletins

follow these easy steps

Preceding pages tell you what's new in plant equipment. Each item is numbered. For more details on any item, write its number here →

New free bulletins are listed and numbered beginning on back of this page. To order those you want, write POWER item number here → — *do not use manufacturer's bulletin number.*

Put 2¢ stamp on self-addressed card and mail it to us. We'll pass along your request to the various companies, they'll send the info

I want details on these New Products:

☐ ☐ ☐ ☐ ☐ ☐

Send me these FREE Bulletins:

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please use before July 1, 1958. Void after this date. **3/58**

My Name .....
Please print

Home Address .....

City & State .....

Title .....

Company .....

Power a McGraw-Hill Publication

I want details on these New Products:

☐ ☐ ☐ ☐ ☐ ☐

Send me these FREE Bulletins:

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please use before July 1, 1958. Void after this date. **3/58**

My Name .....
Please print

Home Address .....

City & State .....

Title .....

Company .....

Power a McGraw-Hill Publication

I want details on these New Products:

☐ ☐ ☐ ☐ ☐ ☐

Send me these FREE Bulletins:

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Please use before July 1, 1958. Void after this date. **3/58**

My Name .....
Please print

Home Address .....

City & State .....

Title .....

Company .....

Power a McGraw-Hill Publication

This Month's FREE Literature

PLACE 2¢ STAMP HERE

Power
Reader Service Department
330 West 42nd Street
New York 36, N. Y.

PLACE 2¢ STAMP HERE

Power
Reader Service Department
330 West 42nd Street
New York 36, N. Y.

PLACE 2¢ STAMP HERE

Power
Reader Service Department
330 West 42nd Street
New York 36, N. Y.

AIR CONDITIONING, HEATING, VENTILATION

1 **Air-moving equipment ratings** are discussed in technical bulletin 153-57. Typical test setups and performance curves included for fans, ventilators. Air Moving and Conditioning Assn, 2159 Guardian Bldg, Detroit 26, Mich.

2 **Air, steam cleaners** are subject of 4-p folder 502. Gives piping details, sizing and installation data. The V D Anderson Co, div of International Basic Economy Corp, 1935 W 96th St, Cleveland 2, Ohio.

3 **Industrial heaters**—construction, application and performance—are described in 26-p bulletin 750A. Gives graphs and charts, dimension diagrams. American Air Filter Co, Inc, 215 Central Ave, Louisville 8, Ky.

4 **Dust-collector** maintenance, water-treatment for wet-type units, is described in 2-p bulletin WDC. Includes case histories. The North American Mogul Products Co, Standard Bldg, Cleveland 13, Ohio.

5 **Air engineering** for process industries is subject of 8-p bulletin 135. Contains descriptions, photos of after-coolers, air conditioners, liquid coolers. Niagara Blower Co, 405 Lexington Ave, New York 17, N. Y.

BOILERS AND ACCESSORIES

6 **Design criteria** for stacks and breechings is subject of 23-p report. Illustrated by line drawings and charts, booklet covers sizing, connections, height, etc. Orr & Sembower, Inc, Morgantown Rd, Reading, Pa.

7 Boiler control systems for large utility power stations are described in 12-p bulletin 1038. Combustion, fuel cutback, feedwater are discussed. Includes 2-p schematic diagram showing component hook-up. Copes-Vulcan Div, Blaw-Knox Co, Erie, Pa.

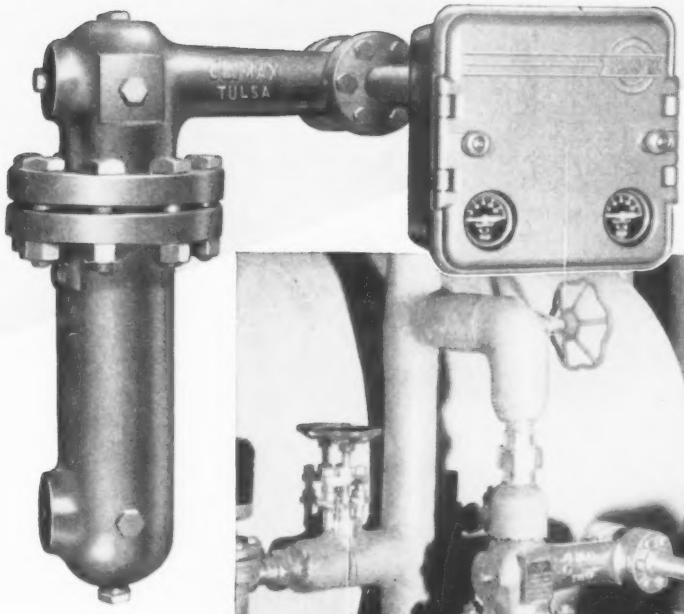
8 Package generators for forced-circulation hot-water systems are described in 6-p spec sheet. Includes diagrams, capacity graphs, operating data. Cyclotherm Div, National-U.S. Radiator Corp, Oswego, N. Y.

9 **Index** to ASME *Boiler and pressure vessel code* is condensed in 4-p folder. Four indexes show location of various design data. Downingtown Iron Works Inc, Dept C, Downingtown, Pa.

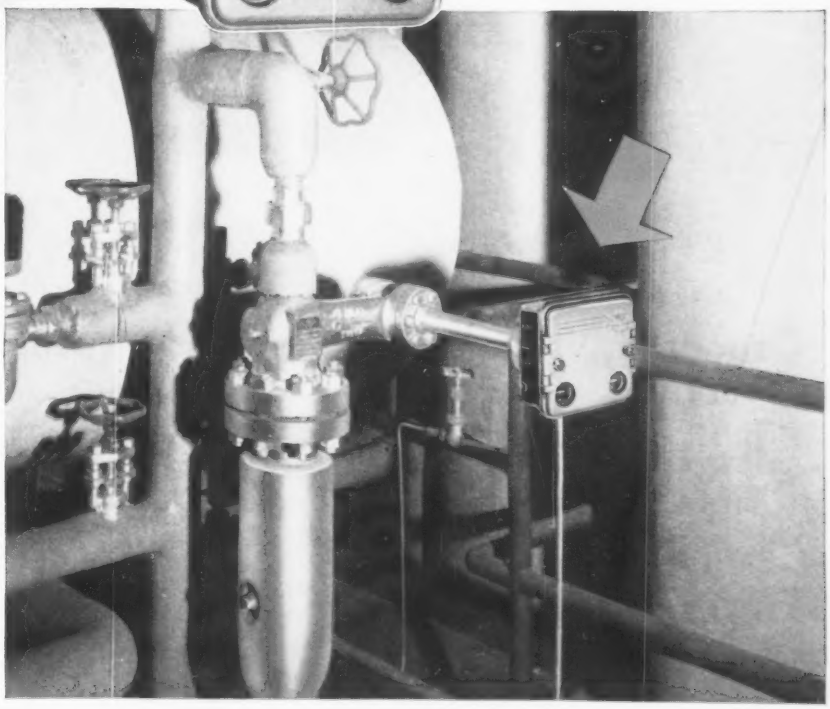
ELECTRICAL EQUIPMENT

10 **Transformers** are subject of 20-p bulletin 61B6186C. Covers power, unit substation, industrial application and instrument transformers. Lists and illus- (*Continued on page* 212)

When An External Cage Type Liquid Level Controller Is Indicated, Specify The . . .



BS&B Type 71-06, Series 2!



OVER 60 YEARS
BS&B
ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

1. **"Built In" Accuracy:** Engineered to control within close level tolerances.
2. **Rugged:** Capable of continuous operation under severe service conditions.
3. **Versatile:** May be either transmitter or controller. Set for differential-gap, on-off, or proportional control. Controller output range in 3-15, 3-27 and 6-30 psig.
4. **Time Proven:** Utilized on heat exchangers, reboilers, deaerators, condenser hotwells and other similar applications in plants the world over.

For Complete Information On The BS&B Type 71-06, Series 2, Or Other BS&B Liquid Level Controllers, Contact Your BS&B Sales Engineer — or Write To . . .

BLACK, SIVALLS & BRYSON, INC.
Controls Division, Dept. 4-Q3
7500 East 12th Street Kansas City 26, Missouri

George Edwards

suggests, "Take a reading on your speech dynamometer"

One evening last December a bunch of us were having a bull session in a hotel room in New York. We'd been listening to ASME papers all day and were relaxing with our shoes off and collars open. Like all bull sessions, this one covered a lot of topics. Batting it back and forth, the talk got around to deer and rabbit hunting—then to dogs.

One of the men brought out some pictures of his two Airedales and with justifiable pride, judging by the dogs' looks, told us how intelligent they were. "This one," he said, pointing to a picture, "is almost human. She's got everything but the power of speech."

He meant, of course, that his dog didn't have the *ability* to talk, but it set me to thinking about the *power* of human speech. What a tremendous effect we can have on people's lives merely by what we say—and the *way* we say it.

I'm not thinking of rumors or gossip. That sort of thing, generally a poisonous brew at best, involves talking *about* the other fellow. What I have in mind is the thoughtless, spur-of-the-moment crack that we're apt to make at times. Maybe we're irritated or worried about something and the guy we lash out at just happens to be the nearest target. Or maybe he's made a minor mistake that we'd normally brush off, but at a time like this he's the stupidest jerk in the world. And we proceed to let him have it. Sure, we're sorry about it a few minutes later, but we feel embarrassed about the whole thing and try to pretend that it never happened.

But to the other guy—it *did* happen. We're in the driver's seat so he keeps his mouth shut to stay out of trouble. He hates our guts for it, though, and has an instinctive desire to "get even" with somebody or something. Maybe he takes it out on the man under him. Maybe he goes back to his job and, in the frame of mind he's in, unintentionally fouls up something or gets hurt. If not this, he's apt to drive home with the same look on his face that he had when he drew a bead with his bazooka on a Commie tank in Korea. Lucky not to crunch another car on the way home, he takes it out on his wife and kids when he gets there.

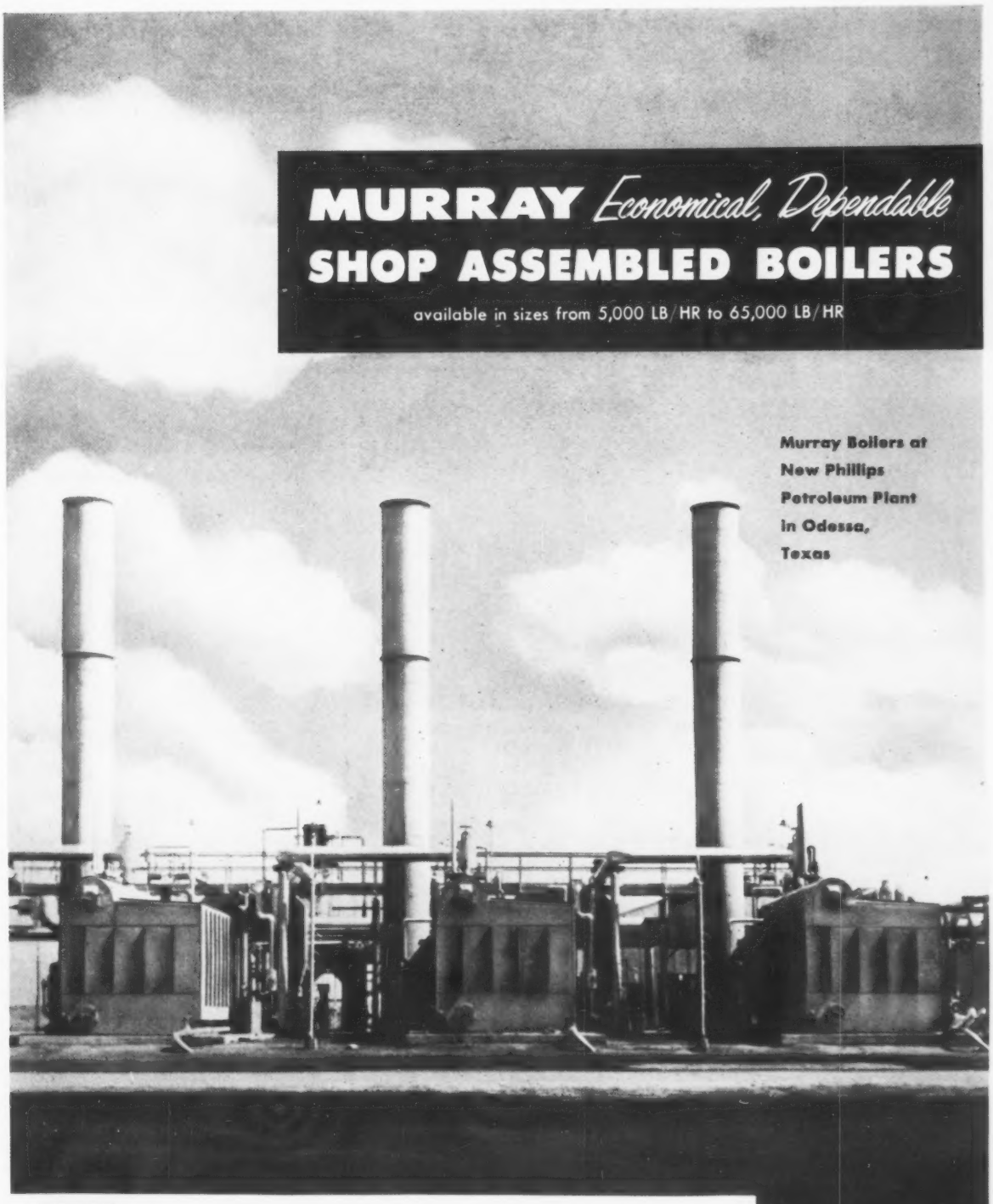
You think this is an exaggeration—that a guy would be a knucklehead to act this way just because his boss blew a gasket that day? Don't kid yourself. How do you know the guy you snarled at wasn't loaded down with his own troubles and you threw that famous straw on the camel's back at just the right, or wrong, moment?

The other side of the power-of-speech coin works magic, too—only more so. A verbal pat on the back, particularly when a guy needs it most, or gentle words when you point out a mistake he's made can start a chain reaction that breeds nothing but good.

Maybe we haven't seen it but we've all read about a fellow who averted a riot with a few calm words or, conversely, a guy who pushed the panic button with his mouth and a lot of people got hurt.

MURRAY *Economical, Dependable* SHOP ASSEMBLED BOILERS

available in sizes from 5,000 LB/HR to 65,000 LB/HR

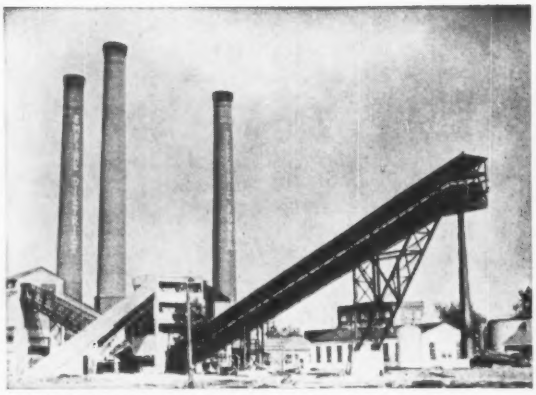


Murray Boilers at New Phillips Petroleum Plant in Odessa, Texas

MURRAY IRON WORKS CO., BURLINGTON, IOWA

Murray Boilers Stand the Test of Time

EARN EXTRA PROFITS IN SAVINGS



McNally Pittsburg developed this 250 ton per hour system for the EMPIRE DISTRICT POWER & LIGHT CO.

McNally Pittsburg assisted in developing this 300 ton per hour system for the KANSAS POWER & LIGHT CO.

—With Cost-Cutting

COAL-HANDLING SYSTEMS

Engineered for Your Plant

Are you paying "extra fare" luxury rates for that last ride your coal must take from the truck, car, or barge, to your bunkers?

Why pay more? Why risk breakdowns, when you can *save* extra "profits" and be sure of year-round efficiency.

McNALLY PITTSBURG Systems automatically handle more coal per dollar—minimum maintenance costs.

The men who know coal from the ground up will be glad to study your coal-handling problems with you. Mail coupon.

M'NALLY PITTSBURG

"The Men Who Know Coal From The Ground-Up"

McNally Pittsburg Mfg. Corp., Dept. PO, Pittsburg, Kansas
Gentlemen: Send more information on your Coal-Handling Systems.

Name_____ **Title**_____

Company_____

City and State_____

Equipment news

Begins on page 164

Reader-enlarger-processor

317 • Unit provides on-the-spot reproduction of microfilmed engineering drawings for reference. It uses aperture cards containing 35-mm film, can also use roll film or acetate jackets in 16-mm or 35-mm size.

Instrument, designated REP II, provides for opaque visual reference to filmed drawings, enlarging them to 17 x 22-in. size on reading table; also makes enlarged photographic prints from cards, which emerge damp-dry within 50 seconds after exposure, according to manufacturer. —*Remington Rand Div, Sperry Rand Corp, 315 Fourth Ave, New York 10, N. Y.*

For more details on these items, use post cards p 171. Identify your request with item number.

Maintenance lapping machine

339 • Designated Model 10 Lapmaster, unit will consistently reface mechanical seals, valve seats, compressor discs or fuel-injector parts to a precision flatness of .0000116 in., maker claims.

Unit does not have to be stopped for redressing or truing lap plate. Flatness of plate is said to be continuously maintained by action of conditioning rings. Machine operates

O-B VALVES

New O-B regrinding swing check valves ONCE IN...THEY STAY IN

There is no need to replace a swing check valve every time the closing surfaces become worn. This new O-B valve can be reground right on the line... your service is interrupted for just a matter of minutes. The "Y" design makes it easy to do the regrinding... or to get to the disc when it needs changing.

Free-swinging action of the hanger assembly permits the disc to clear the entire port under pressure and to close tight at the slightest back pressure. Because two side plugs, instead of the usual one, are provided, the hanger pin and assembly can be removed even when the valve is mounted close to an obstruction.

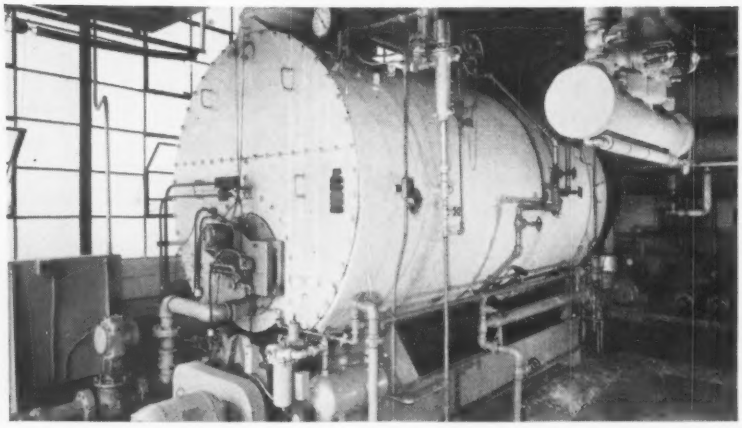
O-B Regrinding Swing Check valves are available in sizes from ¼ through 3 inches for 150 lbs. WSP—300 lbs. WOG and 200 lbs. WSP—400 lbs. WOG.

Ask your local Ohio Brass distributor about the broad line of O-B check, gate, globe and angle bronze valves for industrial applications.

OHIO BRASS COMPANY
380 North Main Street, Mansfield, Ohio

4842-V

Cleaver-Brooks reports on PROCESS STEAM ECONOMY



34 BOILERS – excellent efficiencies minimum maintenance

— National Industrial Laundries, Elizabeth, N.J.

Mr. Freeman A. Godfrey, Chief Engineer, National Industrial Laundries, states, "From actual fuel checks against steam developed, our company is experiencing excellent efficiencies from our 34 Cleaver-Brooks. Loads vary widely in our 20 plants, starting at 100% capacity in the morning hours and reducing to 20% in afternoon.

"Our maintenance story is just as impressive. Due to better combustion, we find it is unnecessary to clean the fireside of boilers more than once every six months. We have not had a serious shutdown due to any lack of emergency service from your field engineers."

Economy and boiler performance like this are typical of hundreds of Cleaver-Brooks installations. Four-pass, forced-draft design has clearly proved its superiority in all types of process steam service.

Today — write for complete information on Cleaver-Brooks boilers: 15 to 600 hp, oil, gas and combination oil/gas firing, steam or hot water for heating and processing. Cleaver-Brooks Company, Dept. C, 301 E. Keefe Ave., Milwaukee 12, Wisconsin.

The 300 hp oil- and gas-fired model LR boiler shown above is installed at Alabama Overall Service laundry in Birmingham, Ala. In addition to this installation, National Industrial Laundries has a total of 32 Cleaver-Brooks boilers in the following plants:

Atlantic Overall Service Scranton, Pa.
Carolina Overall Service Charlotte, N.C.
Central Overall Service Louisville, Kentucky
Colonial Overall Service Richmond, Va.
Delta Overall Service Hattiesburg, Miss.
Dixie Overall Service Greensboro, N.C.
Eastern Overall Service Somerville, Mass.
Floridian Overall Service St. Petersburg, Florida
Gulf Overall Service Atlanta, Ga.
Industrial Uniform Service Chattanooga, Tenn.
Local Overall Service Ft. Worth, Texas
Mechanics Overall Service Newark, N.J.
Mechanics Overall Service Camden, N.J.
Mechanics Overall Service Reading, Pa.
Mechanics Overall Service Alexandria, La.
Mechanics Uniform Service Dayton, Ohio
Southern Overall Service Baltimore, Md.
Texas Overall Service Dallas, Texas
Texas Overall Service Houston, Texas
Tropical Overall Service Jacksonville, Fla.

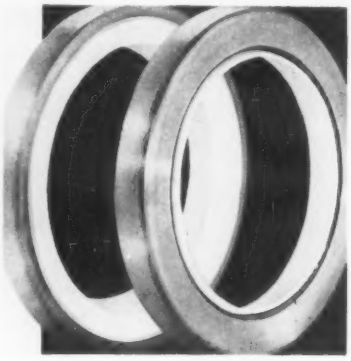
Cleaver Brooks®

ORIGINATORS OF THE SELF-CONTAINED BOILER

Equipment news

Begins on page 164

from standard 110-v 60-cycle single-phase outlet.—*Crane Packing Co, Dept PRN, 6400 Oakton St, Morton Grove, Ill.*



Teflon clipper seals

318 • Units will enable industrial plants to obtain positive sealing in the presence of and in contact with active solvents and corrosives, according to manufacturer. Body of seal is made of Teflon and is encased in stainless steel or other corrosion-resistant alloy. Seal lip is actuated by spring made of stainless alloy. Unit is said to be assembled so all components are in absolute concentricity. —*Johns-Manville Corp, 22 E 40 St, New York 16, N. Y.*

For more details on these items, use post cards p 171. Identify your request with item number.

Slurry feeder

319 • Self-contained unit is capable of handling concentrated slurries to 20% concentration of diatomaceous earth on a continuous basis. Feeder is completely packaged, consisting of reservoir, pumping unit, integral air compressor for slurry agitation and

NOW . . . GREATER CAPACITY than any other standard gearmotor . . . and in smaller space!

Capacity up to 200 hp loads, with ratios up to 440:1—that's what you get with the new Philadelphia Type "G" Gearmotor. No other standard gearmotor or in-line reducer on the market offers such high capacity and rugged construction. Yet its compact design gives you the smallest possible power package for any job. The Type "G" is the answer for any application demanding heavy duty, continuous service performance.

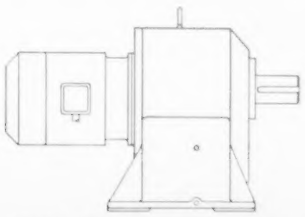
Compact Design. "Shaft-in-line" design makes the new Type "G" Gearmotor more compact and permits complete flexibility in mounting. *Result:* substantial savings in space required. You can even mount the Type "G" without a base plate.

Helical Gearing supports larger loads with maximum power efficiency (96-98%)—assures silent operation, increased strength, longer life. Teeth are crown shaved and induction hardened for optimum performance.

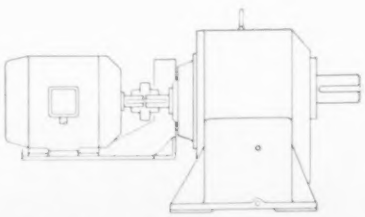
The Type "G" Gearmotor is an extension of the famous Philadelphia Gearmotor Line. It is available as a reducer, gearmotor with motor mounting bracket, or standard gearmotor with flange mounted motor. For complete information, write for Bulletin GM-57-B, Philadelphia Gear Works, Erie Ave. and G Street, Philadelphia 34, Pa.

Offices in Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.

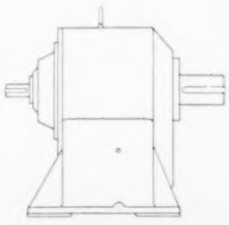
phillie gear®



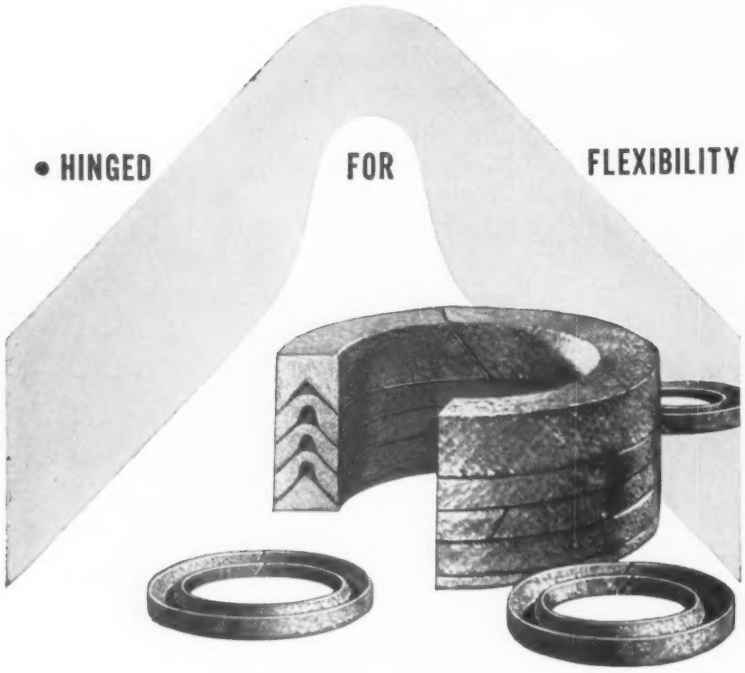
INTEGRAL GEARMOTOR (Flange Motor)



UTILITY GEARMOTOR (Foot Mounted Motor)



IN-LINE REDUCER



BELL-SHAPED V-Design makes BEL-VEE PACKING *pressure sealing*

Scientifically designed to make the pressure seal itself, Bel-Vee Rings expand toward the rod and stuffing box wall, with increased pressure, to automatically form the seal. Then when pressure is relaxed, Bel-Vee Rings contract from the rod for free movement with minimum friction.

That is why Bel-Vee Ring Packing keeps equipment running smoothly—cuts maintenance—lasts longer.

Offered in sets for pressures to 6000 psi for sealing reciprocating rods of pumps, engines, compressors, hydraulic equipment and valve stems.

Bel-Vee Rings are individually molded in practically every rod and stuffing box size, and in a number of basic material combinations for use against water, oil, solvents, steam, air and gas. Catalog No. 56. Also available in du Pont Teflon for all-chemical service. Catalog T-57.

The Belmont Packing and Rubber Company
Butler & Sepviva Streets, Phila. 37, Pa.

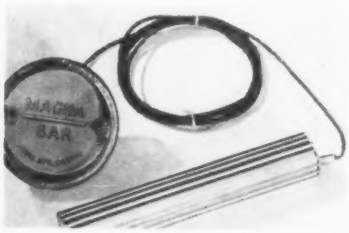
ask your BELMONT Distributor
Such leading Packing Distributors as:
Warren & Bailey in Los Angeles
and
Speck-Marshall in Pittsburg
are ready to supply your emergency as well as regular requirements.

BELMONT

Equipment news

Begins on page 164

electric motor with belt drive, all mounted in free-standing pedestal.—*Wallace & Tiernan Inc, 25 Main St, Belleville 9, N. Y.*



Storage-tank protection

320 • Product is said to eliminate varnish and sludge in heating oils, reduce corrosion of industrial fuel-storage tanks. Device consists of a bar of special alkaline-alloy metal 4-in. long suspended from wire attached to tank cap. Cap, wire and bar come packaged and are available for indoor, outdoor or underground tanks. Unit is said to neutralize catalysts and corrosive acids. — *Johns Manufacturing Co, 672 Bound Brook Road, Middlesex, N. J.*

Constant level oiler

322 • Unit, designated *CR*, covers a capacity range of 2 oz to 1 gal. Advantages are said to be: (1) largest possible internal passages for use of heavier oil (2) top filler cap simplifies replenishing of oil without removing reservoir (3) remote mounting of oiler safely supports large capacities, makes unit suitable for bearings which vibrate if Saran tubing is used between oiler and bearing.—*Oil-Rite Corp, Waldo Blvd, Manitowoc, Wis.*

For more details on these items, use post cards p 171. Identify your request with item number.

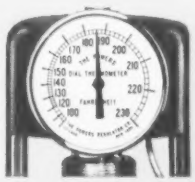
Solenoid drain valve

316 • Direct-acting type solenoid-controlled valve may be used wherever controlled draining or dumping of liquids is required. Absence of obstructions in valve is said to eliminate collection of foreign matter, providing clean, quick drain.

Unit has all-iron construction, stainless-steel seat. Capacity is up to 118 gpm. Comes in 1½- and 2-in. sizes, 15 watts ac.—*Automatic Switch Co, Florham Park, N. J.*

(*Continued on page 182*)

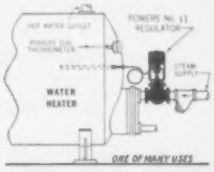
WHY POWERS No. 11 REGULATORS Give BETTER CONTROL and Last Longer



Temperature Indicating Regulator

A Versatile Control for hundreds of applications. Has big 4" easy to read dial thermometer. Gives visual proof of constant temperature control. Helps to accurately adjust the regulator. *A feature originated by Powers in 1930.*

Simplest, Reliable
TEMPERATURE CONTROL
made for: Many Industrial Processes, Heat Exchangers, Air Compressors, Diesel Engines, Fuel and Crude Oil Heaters and Treaters.



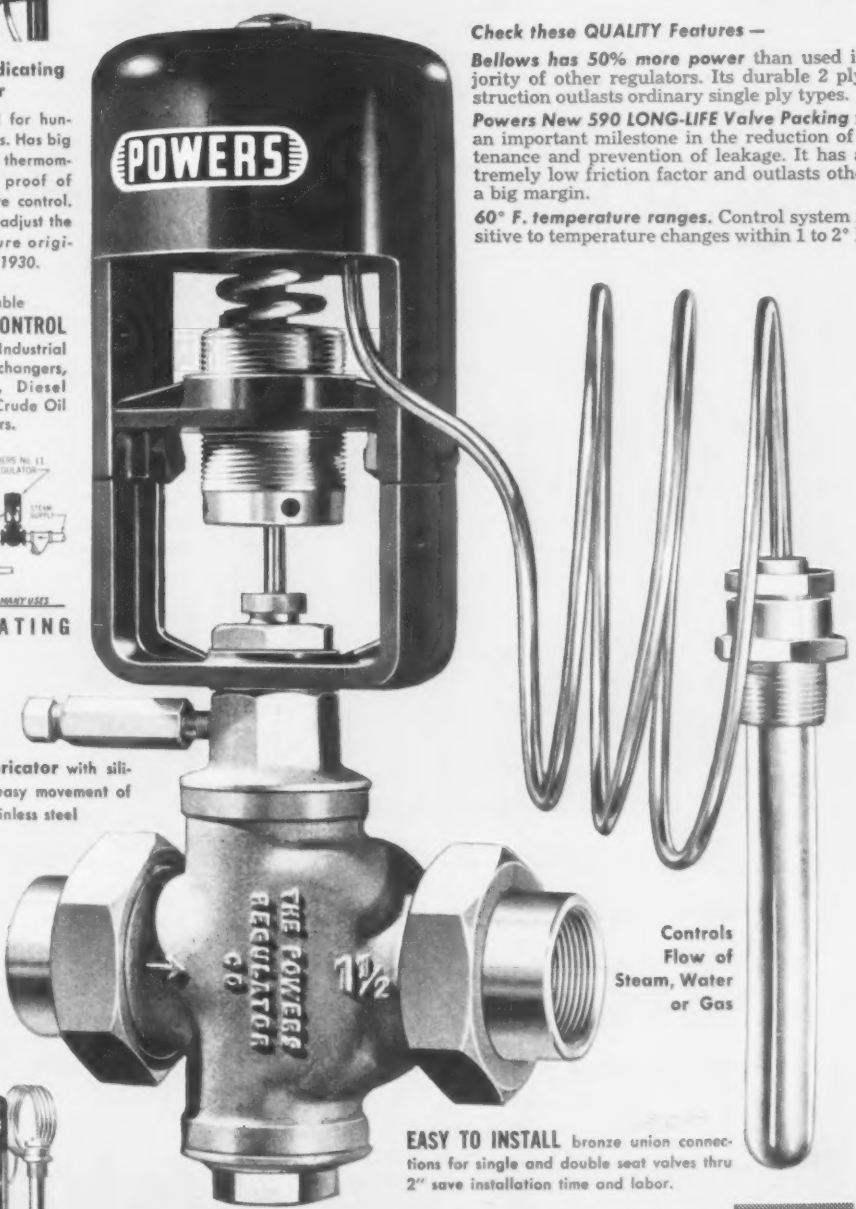
SELF OPERATING

Check these QUALITY Features —

Bellows has 50% more power than used in majority of other regulators. Its durable 2 ply construction outlasts ordinary single ply types.

Powers New 590 LONG-LIFE Valve Packing marks an important milestone in the reduction of maintenance and prevention of leakage. It has an extremely low friction factor and outlasts others by a big margin.

60° F. temperature ranges. Control system is sensitive to temperature changes within 1 to 2° F.

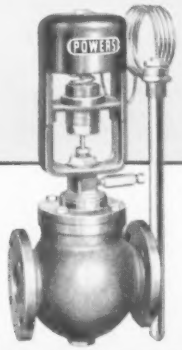


Valve Stem Lubricator with silicone grease aids easy movement of highly polished stainless steel valve stem.

Balanced (Double Seat) Valve

Controls Flow of Steam, Water or Gas

EASY TO INSTALL bronze union connections for single and double seat valves thru 2" save installation time and labor.



Above: Flanged Iron Body Valve with Double Seat for sizes above 2"

Use Powers 65 years of experience and engineering know-how to help you select the right type temperature regulator and right size valve. From our complete line of self operating regulators and air operated temperature controllers you can be sure of getting the control best suited for your requirements.

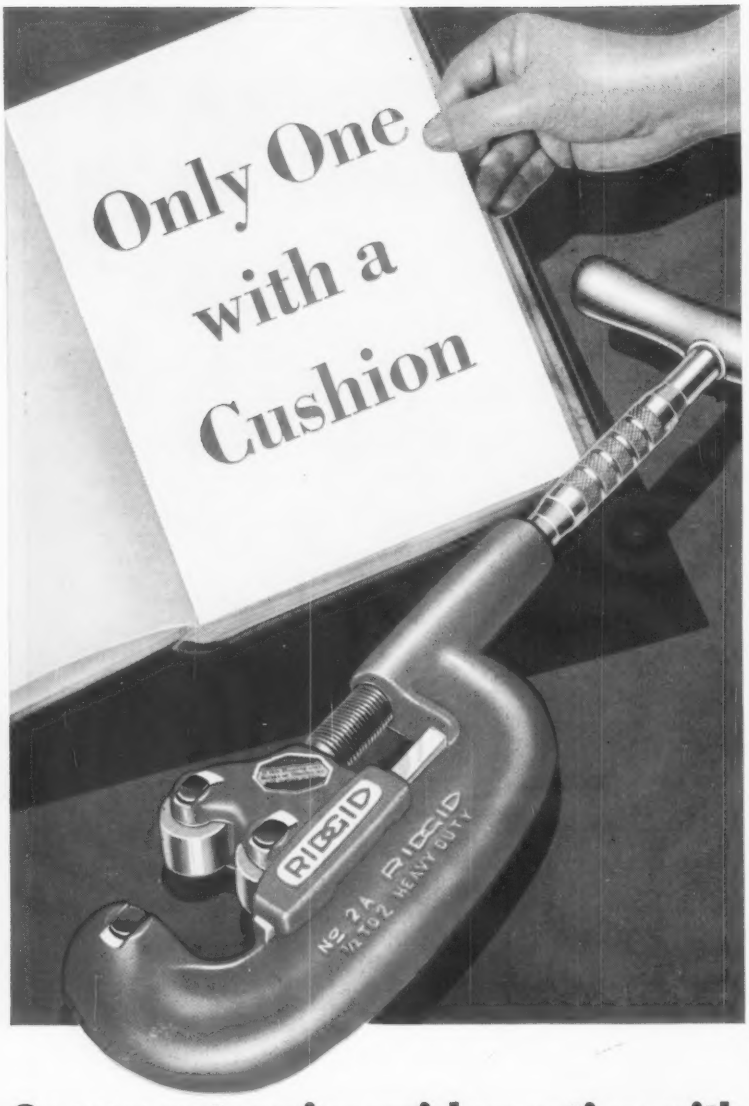
POWERS CONTROL Since 1891

Call our nearest office or write us direct at 3400 Oakton Street, Skokie, Illinois.

(c44r)

Powers offers NATIONWIDE SERVICE in over 85 cities in the U.S. and Canada

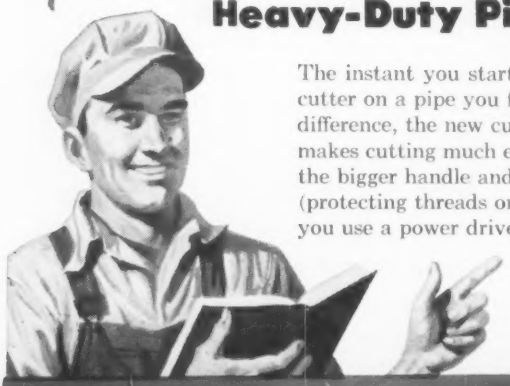
THE POWERS REGULATOR COMPANY



So you get easier quicker action with

New **RIDGID**

Heavy-Duty Pipe Cutters



The instant you start feeding in this new cutter on a pipe you feel the remarkable difference, the new cushioning effect that makes cutting much easier and faster. And the bigger handle and extra long shank (protecting threads on screw handle when you use a power drive) helps, too.

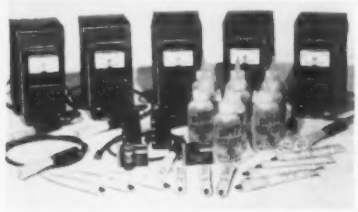
Try it, compare it . . . buy it at your Supply House.

The Ridge Tool Company, Elyria, Ohio, U. S. A.

Equipment news

Combustible gas alarm

323 • Portable, audible unit has visible indicator meter. Alarm is designed for confined-area use, has externally mounted plug-in filament unit for rapid response to gases. Applicable to welding operations in confined areas that have contained flammable liquids, alarm is said to be light, easy to handle.—*Johnson-Williams Inc, 2710 Park Blvd, Palo Alto, Calif.*



Complete pH package

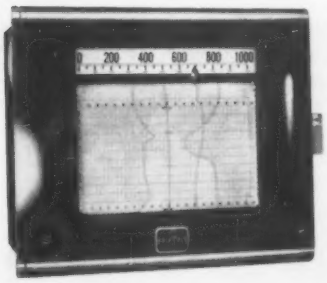
321 • Designed for multi-station use, kit includes five portable instruments with carrying cases and buffer solutions, two buffer kits, two extra probes and two sets of batteries. Kit is said to lessen interdepartment trips, since each department can have its own meter for instant checking.—*Analytical Measurements, Inc, Chatham, N. J.*

Density-measurement system

341 • System measures, controls fluid density, specific gravity, percent of solids or related quantity. It is applicable to liquids, slurries or divided solids, maker claims. Based on gamma-ray transmission from a ra-

Begins on page 164

dioisotope, system makes no physical contact with flowing material. Long-term accuracies of ±.001 to .003 sp gr are said to be possible.—*Industrial Nucleonics Corp. 1205 Chesapeake Ave, Columbus 12, Ohio.*

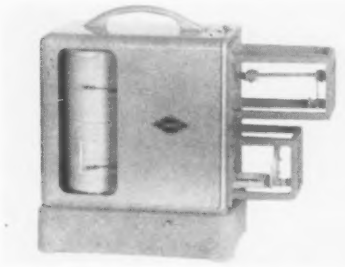


Telemeter receiver

324 • Multiple-printing strip-chart unit will print up to 16 separate records from different telemetering transmission centers.

Instrument uses multiple-switching arrangement, can monitor a large number of values from any distance necessary, manufacturer states. Variables need not be all one kind. Unit prints on 12¼-in. chart, comes with 5-sec or 15-sec time-impulse telemetering system. *The Bristol Co, Waterbury 20, Conn.*

For more details on these items, use post cards p 171. Identify your request with item number.



Hygrothermograph

337 • Heavy-duty indoor-outdoor unit is said to provide equally accurate humidity and temperature indications both direct-reading and recording. Hygrometer accuracy is repeatable within ± 3% relative humidity. Operating range is 15 to 95% rh at temperatures from 32 to 130 F. Temperature-sensitive element of cantilever-type bi-metal is accurate within ± 1 F from 0 to 100 F, according to maker.—*Serdex, Inc, 12 Bowdoin Sq, Boston 14, Mass.*

This New

RIDGID 4PJ

is the only 2½" to 4" geared threader that's

Jam-Proof

It's safe—can't jam and knock equipment around when you thread pipe by power drive. Automatically kicks out after standard thread is cut. Workholder sets to size *before* putting on pipe — other easier work features. See it at your Supply House!

The Ridge Tool Company, Elyria, Ohio, U. S. A.

RAMBLINGS ON INSTRUMENTATION

One good package deserves another

The trend to pre-assembled or "packaged" products has spanned everything from cake mixes and frozen TV dinners to naturally enough, boilers.

In step with the supermarket trend in the power field, Hays manufactures "instant" controls, completely pre-assembled and packaged and ready for use with your new package or field-assembled boiler. A wrench and a handy a-c outlet are just about all you need.

The packaged controls we make are designed specifically to deliver the economy you hoped for when you invested in a new boiler. We manufacture these electric automatic controls in ten different systems, each of which is sympatico with a particular boiler type.

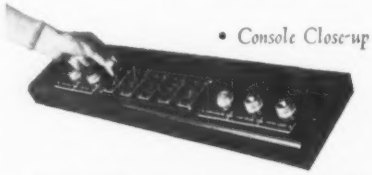
Hays electric control packages are complete. Controllers, instruments, switches, valves, strainers, regulators, egg yolks . . . everything is in position. Installation is simple, but if you're all thumbs, a service man of your local Hays representative is available to help with installation and start-up.

• *Packaged Control Panel*

Hays control systems possess more virtues than you could reasonably expect from their flesh-and-blood counterparts in the human race: sobriety, patience, alertness, stamina and all that. Yet they demand nothing from Man save an occasional swipe with a dustcloth and an affectionate pat.

Undistracted by the superintendent's blond secretary or World Series pools, they concentrate on what's going on inside the boiler. They automatically modulate the boiler from maximum to minimum load at peak efficiency, and even to low load on-off operation. As required, they will take a boiler in or out of operation safely and automatically.

Switches and indicating lights are grouped neatly on a handsome console set at keyboard height (see keyboard and well-manicured hand below) with enough room left over for a brace of candelabra—if you like atmosphere in the boiler room.



• *Console Close-up*

Your consulting engineer will usually recommend that you place the responsibility for providing controls with a control manufacturer, rather than the boiler manufacturer. This makes sense. It affixes the responsibility for safe, efficient control where it ought to be and relieves everyone concerned of a potential king-size headache.

Whaddaya know? Premiums!

In a moment of sheer madness, we bought some miniatures of our packaged controls designed for use as banks. Idea was that this gets across the association of Hays controls with economy. Well, anyway, we have them. You might like one for your kids or yourself. Ask for a couple and make our ad manager happy. He sometimes gets pensive wondering "does anyone *read* all that copy?"

For a prose treatise on our complete line of Electric Packaged Control Systems, drop me a hint that you'd like our bulletin 57-1088-239, just off the press.

Phil Sprague Jr.

President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

Marmaduke

Continued from page 154

"BILGEWATER on Windy Willis!" roared Marmy in his foghorn voice. "He didn't operate that boiler room, it ran in *spite* of Windy! But don't ask me how!"

That did it. The chatter stopped, all put down their drinks or stopped eating and every eye turned towards the great Surfaceblow, for he was about to sound off. Marmaduke waded right in. When he had something to say, he said it, come hell or high water. Throwing back his head and lighting a piece of rope yarn he fished from his pocket, he began.

"I had a date to give Windy's boiler an internal one day back in '22 when I was a state boiler inspector. She was an old economy-type boiler and was fed from the Grand River a half mile away. The water was pumped to a tank on the boiler-house roof, and from there it gravitated for filling whenever the boiler was dumped for cleaning. Using water from that tank was the only way to fill the boiler when the boiler was dead.

"I made the internal and found the old kettle in fair shape, considering Windy's feedwater treatment and the river water he used.

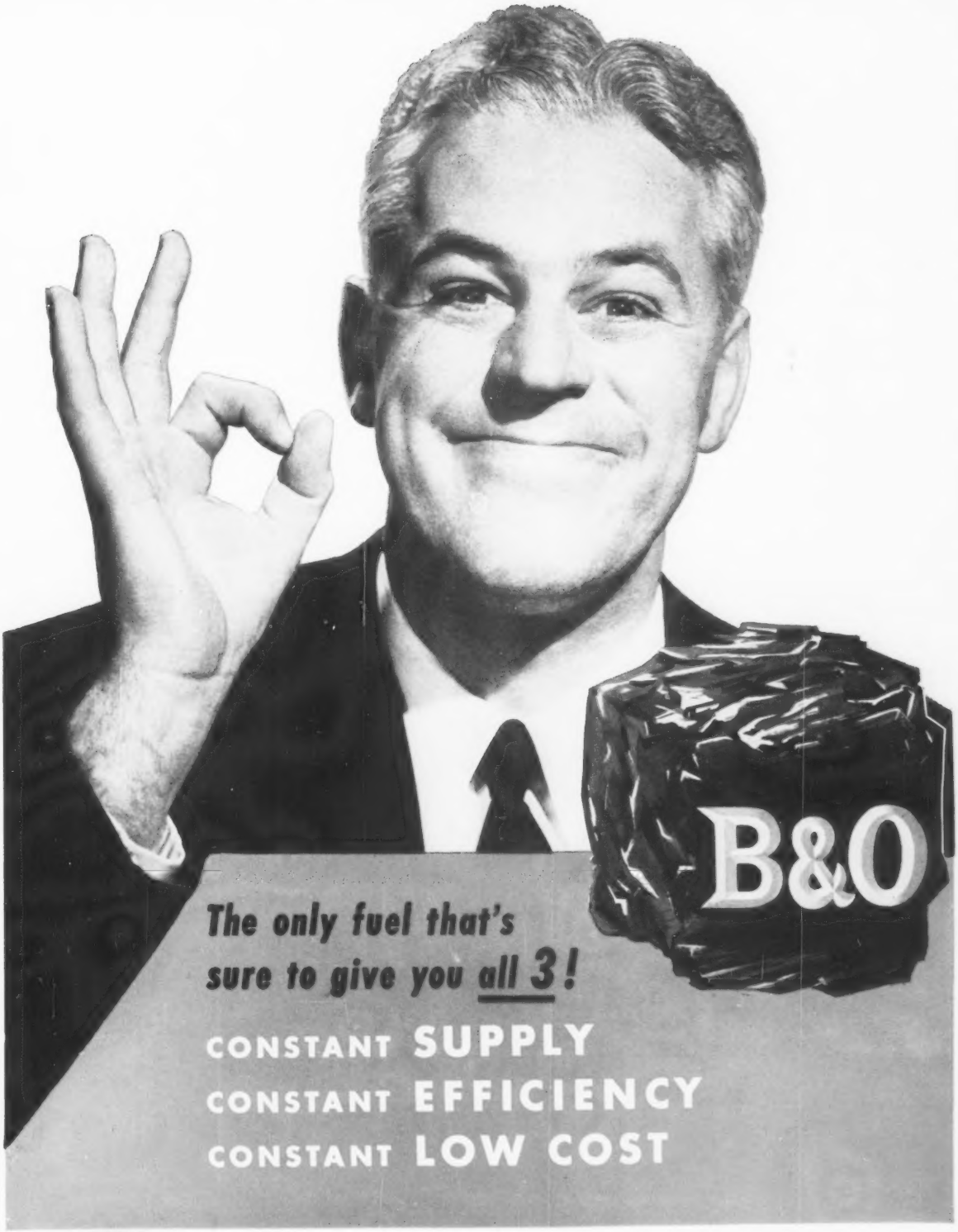
"After crawling out of the steam space, I took a blow while waiting for Windy to fill her with water for the hydrostatic. I got a little annoyed about him filling the furnace with firewood and wasting my time instead of filling the boiler with water. But I didn't say anything.

"Then he did something that made my eyes pop out. As soon as the manhole plates were on, he lit a wad of oily waste and started to throw it into the furnace. 'Hold on there, you brainless baboon!' I yelled at him, grabbing his hand just in time. 'Don't you know there ain't any water in that boiler? What you trying to do, burn her up?' I had all I could do to keep from cracking that jughead of his.

"'Don't get your steam pressure up, Inspector,' came back Windy. 'I got to fill the boiler with water, don't I?'

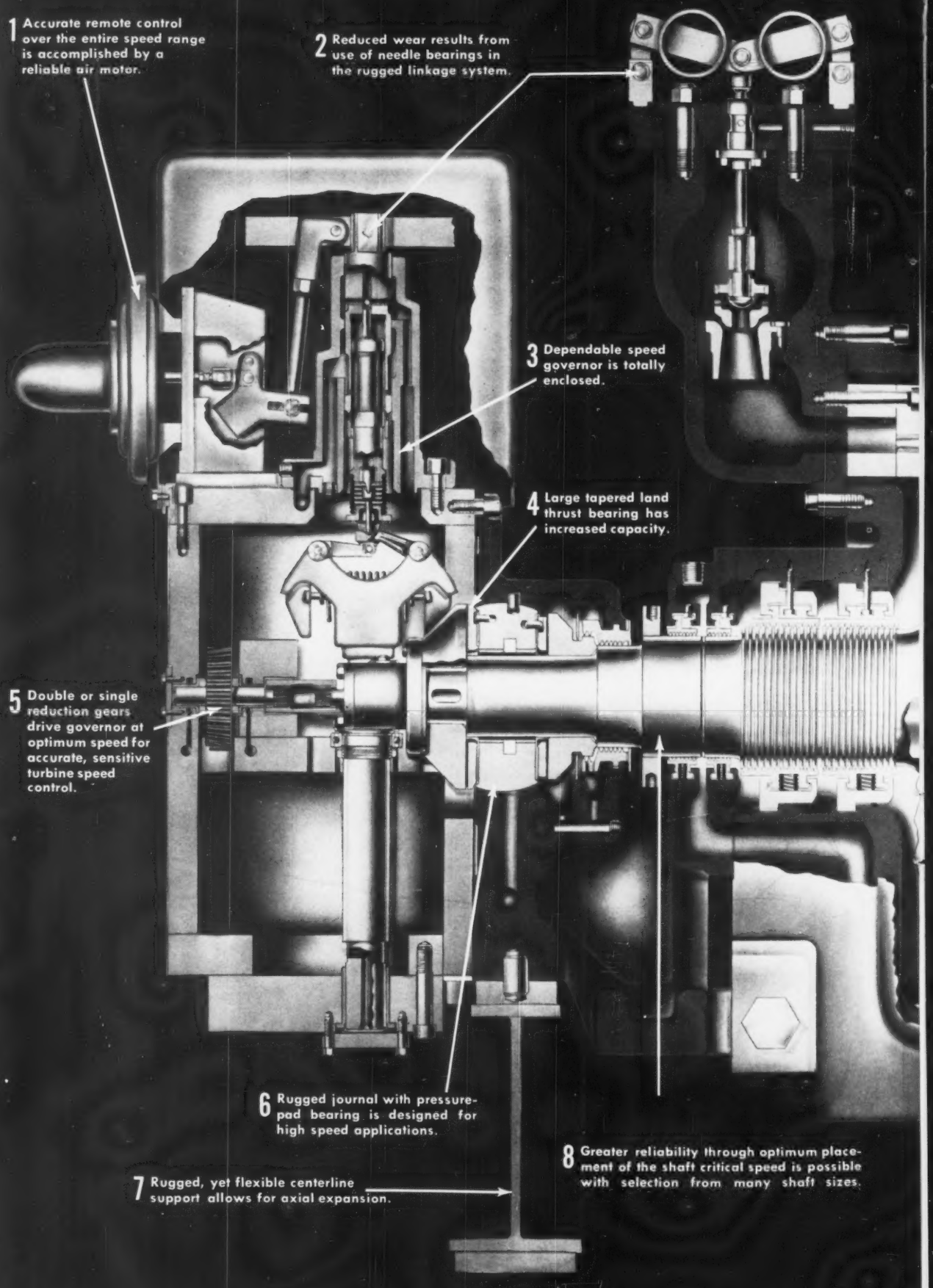
"'Sure' you got to fill her with water, how can I give her a hydrostatic if you don't,' I said, getting sore about his dumb question. 'But

(*Continued on page* 188)



B&O BITUMINOUS COALS FOR EVERY PURPOSE

Ask our Man! BALTIMORE & OHIO RAILROAD, BALTIMORE 1, MD. *Phone* LExington 9-0400


1 Accurate remote control over the entire speed range is accomplished by a reliable air motor.
2 Reduced wear results from use of needle bearings in the rugged linkage system.
3 Dependable speed governor is totally enclosed.
4 Large tapered land thrust bearing has increased capacity.
5 Double or single reduction gears drive governor at optimum speed for accurate, sensitive turbine speed control.
6 Rugged journal with pressure-pad bearing is designed for high speed applications.
7 Rugged, yet flexible centerline support allows for axial expansion.
8 Greater reliability through optimum placement of the shaft critical speed is possible with selection from many shaft sizes.

New General Electric turbine front standard helps give

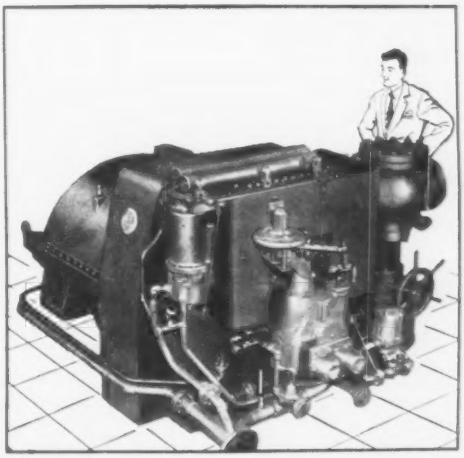
PROFITABLE POWER

by matching process demands for more hp, higher rpm

Now you can drive larger and faster compressors with rugged General Electric mechanical drive turbines. G-E turbine design matches the trend to higher horsepower and speed with a new front standard which allows power in the range of 15,000 hp and speeds up to 12,500 rpm. It can help bring profitable power to your operations.

The new front standard, with its larger selection of shaft diameters and increased thrust bearing and journal capacity, allows optimum placement of shaft critical speeds. This contributes to more reliable operation and longer life at these higher horsepowers and higher speeds.

Find out more about the long term economy of dependable G-E mechanical drive turbines. Contact your nearby G-E Apparatus Sales Office, or write to Section 241-10, General Electric Company, Schenectady 5, New York.



G.E.'S HIGH-SPEED mechanical drive turbine line meets modern process industry demands for higher horsepower and higher speed.

Progress Is Our Most Important Product

GENERAL ELECTRIC

I wish we had more personnel and time to prepare this study for a new power plant and site.

Your regular staff is overloaded now. Call in the specialists and let them carry the peak load. How about Pioneer?

Give your non-routine operations to Pioneer

Design and Consulting Engineering Services. Pioneer has specialized in designing power plants for 56 years. It offers design service for fossil fuel, hydro and atomic plants. It will also assist in forecasting load growth, in site selection, in purchasing and expediting of equipment and in supervising construction. Pioneer's other services include substation, transmission and distribution studies and design.

Services in Regulatory Matters. Pioneer offers its services in all phases of Federal, State and Local regulation including the rate base, depreciation analysis, cost of service studies, market analysis, certificate proceedings and rate of return.

Corporate Services. Pioneer's services in corporate matters include business and management engineering advice, financial, accounting and tax counsel and insurance and pension plans and programming. It maintains a complete stock transfer, ledger and dividend disbursement service.

NEW!
On your letterhead, write for 40-page booklet, "Pioneering New Horizons in Power". Describes Pioneer's engineering services, and corporate services, from financing to operation.

56 YEARS

Pioneer Service & Engineering Co.

231 SOUTH LA SALLE STREET, CHICAGO 4, ILLINOIS

Marmaduke

Continued from page 184

what's that got to do with you firing a dry boiler?'

"That question really got Windy sore. He sputtered and fumed, then he started turning pink around the gills. Before I could say anything, he threw his cap against the boiler and blasted away. 'I got to put a fire under her so I kin have steam so I kin run the feed pump so I kin pump her full of water — else you don't get no water for your hydrostatic!'

"That had me speechless for a second, but only a second. I couldn't believe my ears. I took a good look at him, but he was as sober as I was. 'Before I answer your question about getting steam from a dry boiler, tell me why you don't fill her with water from the roof gravity tank,' I said, trying hard to keep calm.

"'By gravity?' Windy sneered, trying to laugh. 'How the devil kin I fill her by gravity when I used that water this morning to cool down the boiler so you wouldn't get roasted making your internal?'

"I gave up. Sitting on the feed pump, I lit a cigar, all the time trying to keep from blowing a gasket. Then I counted to ten. Then to 100. Finally I stood up and asked Windy to round up a gang and get a bucket brigade going from the creek to the boiler until they had water coming out of the air vent.

"Windy thought I was crazy, but he saw I meant business. He got a dozen men from the shutdown plant and by late that night the boiler was full. I gave her the hydrostatic with a hand pump and then caught the midnight train back to Detroit."

Marmaduke stuffed his mouth with kippered herring and finished up with these last words, "Windy only *thought* I was crazy — But I *know* he was."—*SME*

Likes Fiction

Reading my new *Marmaduke Story*, I think that this series of fiction in an outstanding industrial magazine is terrific. Here at Magnaflux Corp we are most impressed with Marmy. I only wish I had the ability to write of some of the strange, weird and fascinating consulting engineering stories we run across.

F S Catlin, *Chicago, Ill.*

VISIT US AT
THE DESIGN
ENGINEERING SHOW
BOOTHS 481, 483 AND 485

ASCO
BULLETIN 8022 - SAFETY SHUT OFF VALVE
TO OPEN - PUSH BUTTON ON HANDLE, MOVE TO FULL LEFT. IF CURRENT IS ON, VALVE WILL LATCH AND CAN BE OPENED BY MOVING HANDLE TO FULL RIGHT.
TO CLOSE - OPEN ELECTRICAL CIRCUIT, OR PUSH BUTTON AND MOVE HANDLE TO FULL LEFT.
OPEN
SHUT

New ASCO SAFETY SHUT-OFF VALVE provides tight seating... large flow capacity

FM
Factory Mutual Approved

Important design features of this new ASCO valve — absolutely tight seating on gas — and large flow capacity — ideally suit it for use as a safety shut-off valve on gas and oil fired furnaces, ovens and boilers.

This new ASCO Solenoid Valve, Bulletin 8022, assures safe operation because its globe type seating, with integral crown type seat and soft composition disc, tightly seals off gas or oil. A unique combination — Y type body and oversize port (in 1¼"-3" sizes) provides flow almost equal to that of a "straight through" gate valve. Factory Mutual Laboratories has approved the Bulletin 8022 in 1¼"-3" sizes for handling manufactured, natural, and L-P gases in maximum ambient temperatures of 104° F. Valves can also be used for fuel oil and non-corrosive liquids and gases.

This free handle valve must be manually opened — it can only be opened and remain in the open latched position when the solenoid is energized. When the solenoid is de-energized, the valve will trip closed.

- **Dependable Control by ASCO.**

  The ASCO Bulletin 8022 comes in sizes ¾" through 6", with pressures ranging from 25 to 150 p.s.i. It has been designed to permit mounting in any position. This eliminates piping problems that occur with valves that must be mounted in one position. Valves are available with general purpose, watertight or explosion-proof solenoid enclosures to meet any requirements.

  For further information, write for ASCO Bulletin 8022. Or call the ASCO Engineer. He can give you full data on this valve, and on ASCO's complete line of 2, 3, and 4 way solenoid valves.

- **Special Features**

  Auxiliary Switch for operation of controls and signals. Time Delay to prevent valve from closing on a momentary loss of power.

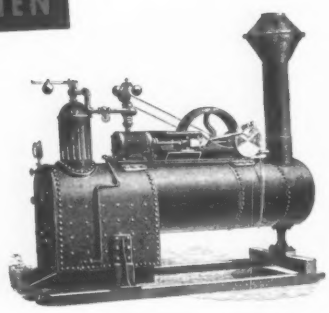
AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES ELECTROMAGNETIC CONTROL

Automatic Switch Co.

54-I Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO®

THEN



WHAT'S IN BETWEEN THESE BOILERS BY BIGELOW ?

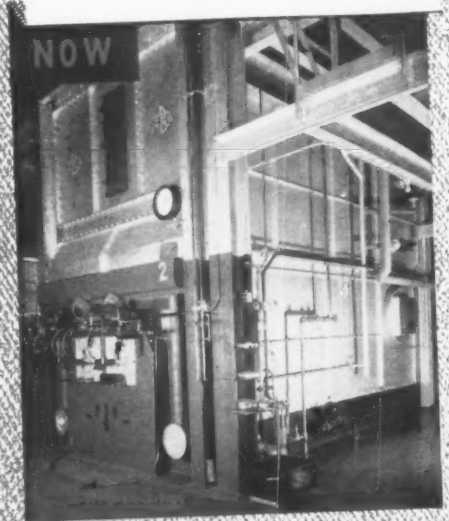
1958 Marks The 125th Anniversary of BIGELOW

During that century and one quarter, Bigelow's reputation has been written in steam by thousands of successful, efficient and long-lived boiler installations all over the world.

What This Means To You

When you are in the market for a new boiler, you can take advantage of the experience and progress in design, construction and inspection embodied in Boilers by Bigelow.

Write for free catalogs on any of the units listed.



THEN
This coal-fired boiler was one of the early Boilers By Bigelow.

NOW
Bigelow boiler installed recently at Waterbury Hospital, Waterbury, Conn. Capacity 23,000 lbs. steam per hour. Oil-fired.

Boilers By Bigelow

Water Tube Boilers

Horizontal Return Tubular Boilers

Scotch Type Boilers

Two-Pass Boilers

Electric Steam Generators

BI-2r

THE BIGELOW COMPANY • NEW HAVEN 3, CONN.
Founded 1833
BIGELOW REPRESENTATIVES: Boston • New York • Chicago • Orangeburg, S. C. • Philadelphia • Syracuse • Detroit • Washington, D. C. • San Francisco • Atlanta • Los Angeles • Milwaukee • New Orleans • Petersburg, Va. • Seattle • Indianapolis • Kansas City, Mo. • Tulsa • Salisbury, Md. • Greensboro, N. C. • Cleveland • Cincinnati

Feedwater heater

Continued from page 103

steel impingement surfaces opposite the nozzles in the distributor avoid eliminating tubes to make room for a bolted impingement plate that may corrode or break away. Annular space in the distributor gives best possible steam distribution.

Incoming superheated steam passes through a jacketed chamber in the annulus. The jacket, surrounded by saturated steam, prevents superheated steam from contacting the tube sheet, distributor or shell. This reduces extreme temperature gradients across tube joints and shell connections. The steam flows through a desuperheater section into the condensing zone. Condensate flows through a subcooling zone before leaving the heater. Welded shrouds separate the zones.

The final round-seam weld is made at an enlarged section of the shell having an inner sleeve with the same ID as the rest of the shell. To remove the shell for maintenance work on the tube bundle, the shell can be torch cut at the bulged section, later rewelded and locally stress relieved. The inner sleeve protects the tubes from damage by welding slag or burn-through.

The spherical-head design has patents pending.

Valve standard

Continued from page 110

And these sizes relate back to existing standard pipe outside diameters.

Assume that with the proposed valve standard we select a pipe inside diameter of 6½ in. This is between the proposed 10- and 12-in. valves. Probably wass thickness needed in this extreme-pressure range will yield an outside diameter between 10½ and 11 in. This pipe can be readily attached to either the proposed 10-in. or 12-in. valve.

In the case of the 10-in. size, about ⅜-in. of material on a side has to be bored out at the welding end to bring the welding lips into conformity. At the outside diameter, only a small transition slope to the weld is needed. With this heavy-walled material it is almost impossible to mismatch odd sizes of pipe with the proposed valve sizes. There is so much metal physically in the welding ends that quite

In Services Where Maintenance Reduction *Depends on All Parts Being Easily Renewable*

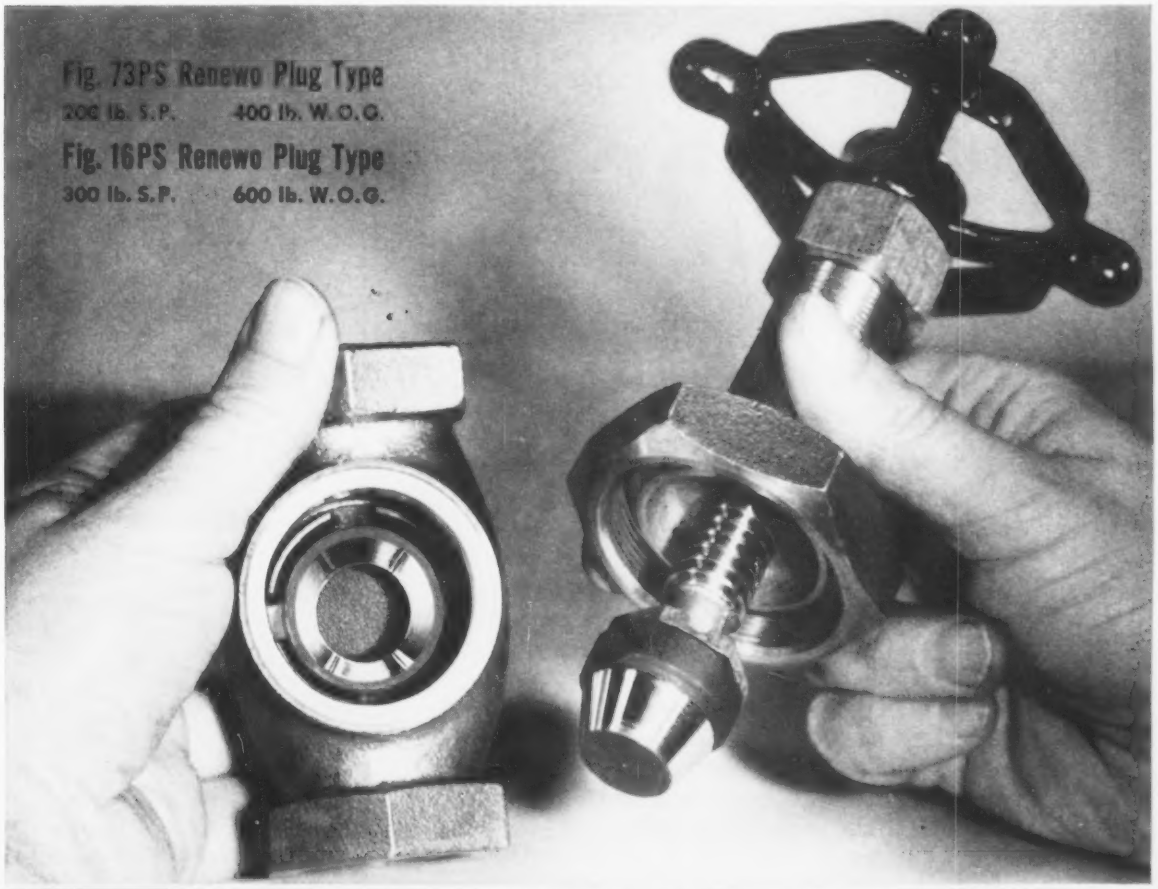
LUNKENHEIMER RENEWO

Hard-to-handle, time-consuming replacement jobs mean higher maintenance costs. That's why it pays to install Lunkenheimer Renewo Valves. Because all replaceable parts are precision machined to an exact fit, no trial-and-error fitting is required.

Durable 500 Brinell Plug-Type Stainless Steel seats and discs are designed to be easily renewed . . . go back into service fast . . . save your maintenance dollars.

Your Lunkenheimer Distributor will be glad to demonstrate these and the many other maintenance-saving features found only in Renewo Valves.

Ask him for a comparison test. He will match Renewo against any other renewable-parts valve in your plant. Or write The Lunkenheimer Co., Cincinnati 14, Ohio.

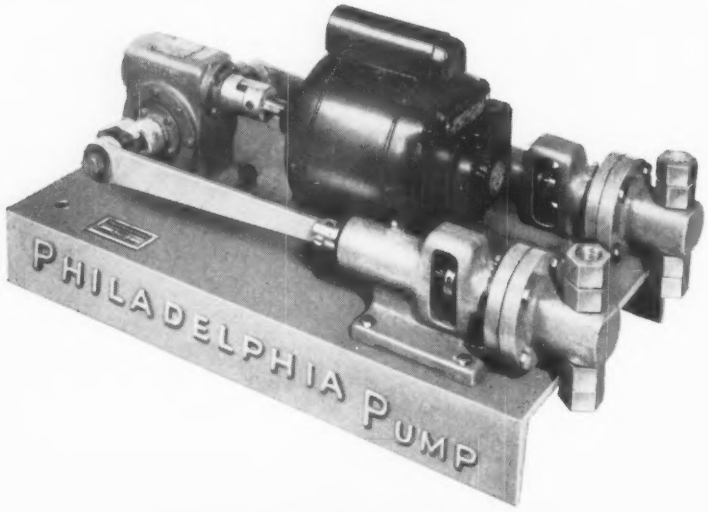


LUNKENHEIMER QUALITY

LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

PHILADELPHIA



controlled capacity

PUMPS

Accuracy and low maintenance to meet fluid proportioning requirements in Chemical Processing, Refining and Boiler Feed Applications.

Philadelphia proportioning pumps feed precisely metered fluids or slurries into low or high pressure systems in nearly any desired ratio with flow, temperature, pressure, conductivity, PH and other controlled process variables. Control may be manual or automatic—with electric, hydraulic or pneumatic systems.

Models may be obtained to handle a great variety of "tough," corrosive and viscous materials. *Write for full information.*

PHILADELPHIA PUMP

Division of American Meter Co.

13500 Philmont Avenue, Philadelphia 16, Pennsylvania

High-Pressure Pumps • Controlled Capacity Pumps • Chemical Feed Systems

Valve standard

Continued from page 190

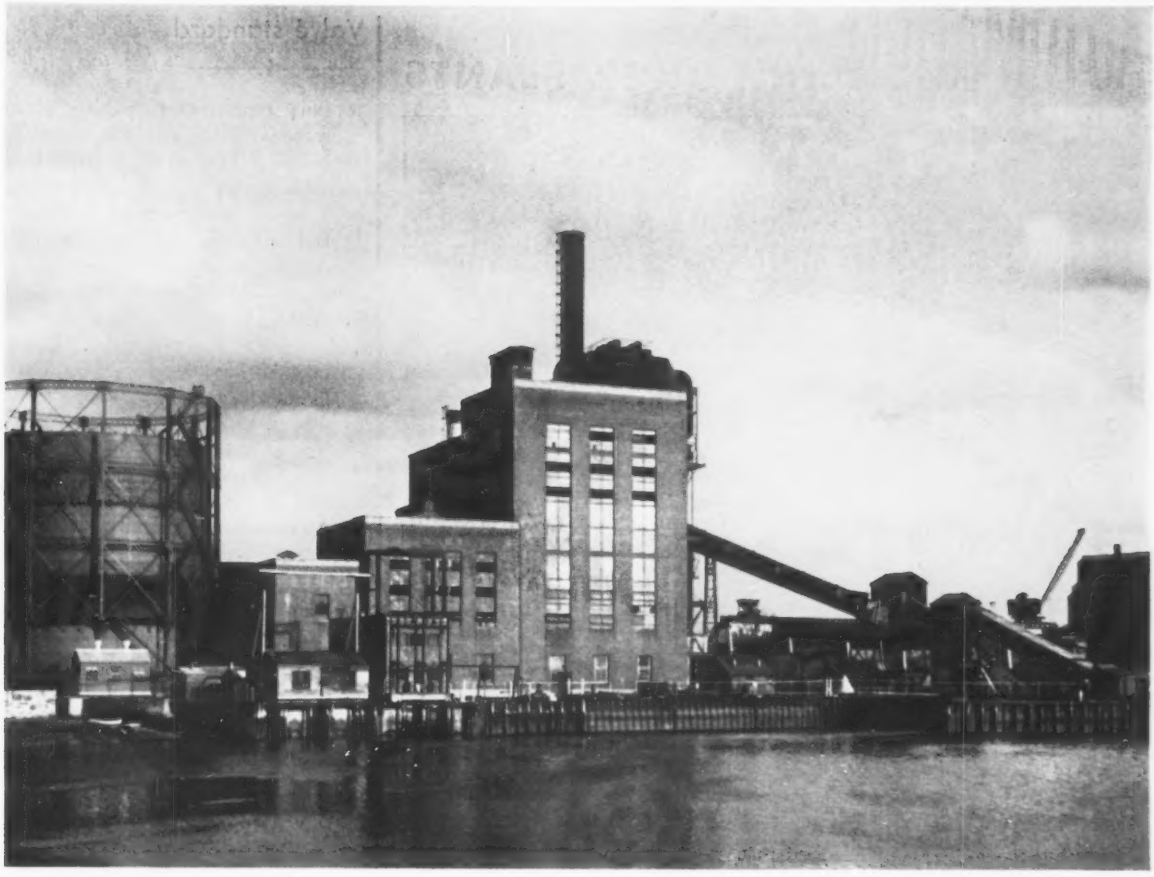
a variety of diameters can be accommodated.

A general question that many brought up is whether or not the present standard system of indicating pipe sizes should be continued on into these very heavy pressure classes. We have the precedent of the 1500- and 2500-psi classes. With the current pipe-size designation system, an increase in pressure class results in a decrease of about one pipe size. For example, a 10-in. 1500-psi valve or fitting has an $8\frac{5}{8}$-in. port diameter. A 12-in. 2500-psi valve or fitting has essentially the same inside port. Consider the designer with a new boiler that takes him just over the allowable pressure range of the 1500-psi class. If he holds to port diameter as his basic design requirement he pays a penalty in higher cost for both the increase in pressure rating of the valve or fitting and for the increase in size. Between these two factors, the price of his valve or fitting may increase as much as 100%. But experience shows that power-generating units operating at higher pressure handle higher density fluids at higher-than-usual velocities. Hence, there is no need for keeping the same inside pipe diameter. Many designers meeting this problem merely switch from a 10-in. 1500-psi valve to a 10-in. 2500-psi valve in spite of the change in port size.

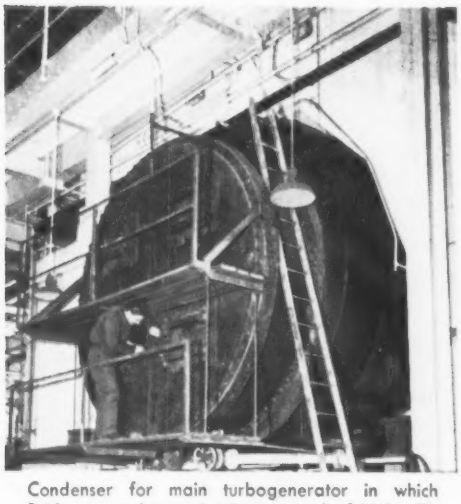
Can this thinking be carried over to a 4500-psi series? Note that the proposed port diameters represent actually a little more than one size reduction in port diameter. For example, an 8-in. 1500-psi valve has roughly a 7-in. diameter port. A 10-in., 2500-psi valve is roughly the same. The combination 12-in.- and 14-in.-size valve has the 7-in. diameter port.

This matter of size designations is perhaps more of an industry trade practice than a true engineering standard. But for purposes of design and negotiating, it will be wise to settle at an early stage the matter of proper size designations for valves in this high-pressure series. This is one objective of our proposal.

Whether there is a better method of selecting wall thicknesses in this very high-pressure range, of course, is a question that is never settled. Final choice of a wall-thickness



After 17 years...
99% OF ORIGINAL BRIDGEPORT TUBES STILL GOING STRONG



Condenser for main turbogenerator in which Bridgeport tubes maintain a record of high efficiency and long life.

This steam condenser tube record at a New England utility isn't often equaled. The 25,000 sq. ft. condenser in this plant contains 4,340 18-gauge Bridgeport Aluminum Brass tubes, each 22 ft. by $2\frac{7}{32}$ in. In 17 years of operation only five tubes have had to be replaced.

The plant serves 100,000 people, generating a total of 65,000 kw. The condenser uses harbor salt water, filtered through half-inch mesh screening with chlorine added for slime control. The harbor water has a high ammonia content.

Tubes are Aluminum Brass—77% copper, 2% aluminum and 21% zinc—a *standard* Bridgeport alloy that, in this case, is giving *exceptional* service.

Making the exception the rule is an everyday occurrence at Bridgeport. Technical Service, research, and manufacturing techniques and facilities—all are aimed at duplicating stories like this in condenser and heat exchanger operation.

A call to your nearest Bridgeport Sales Office puts this assistance at your elbow.

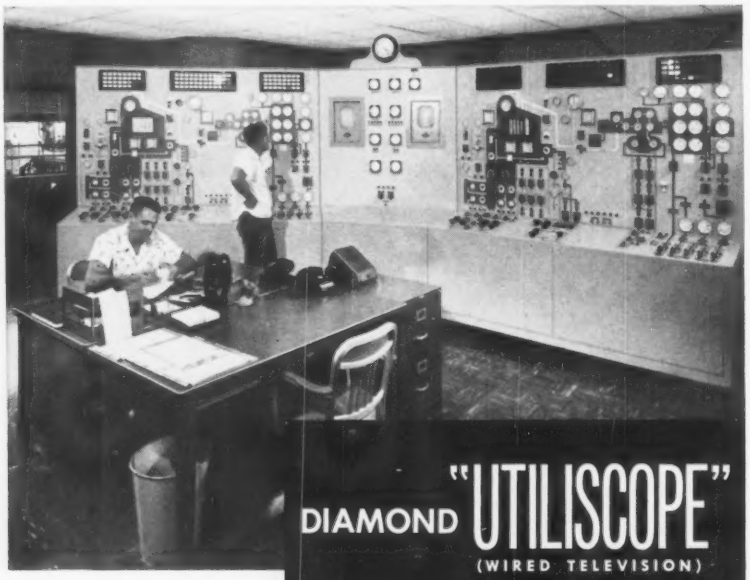
BRASS Bridgeport I.D.

BRIDGEPORT CONDENSER TUBES

Bridgeport Brass Company, Bridgeport 2, Conn. • Sales Offices in Principal Cities

In Canada: Noranda Copper and Brass Limited, Montreal

AUTOMATION IN POWER PLANTS



DIAMOND "UTILISCOPE"
(WIRED TELEVISION)
HEAVY DUTY EQUIPMENT FOR VISUAL INFORMATION

"UTILISCOPE" CAMERA

"UTILISCOPE" RECEIVER

The Diamond "Utiliscope" makes possible the ultimate in automation for power plant control. It enables the operator to see clearly anything that requires visual check. He no longer need depend upon indirect interpretations to know what is happening outside his range of vision.

The operator in the above photograph is watching the ITV image of the water level in two boilers . . . transmitted by "Utiliscope" cameras focused on Diamond Bi-Color water gauges. The water levels are easily and unmistakably read on the viewing screens. There can be no error . . . the level is shown correctly or there is no picture.

The Diamond "Utiliscope" is heavy duty equipment for power plant application. Other power plant uses are: watching flame conditions in boiler furnances, watching smoke emission from stacks, and watching remote entrances for intruders. Have you explored the "Utiliscope's" resources for saving money and improving operation? Use the coupon below for further information.

Diamond

DIAMOND POWER SPECIALTY CORP.
FIRST IN INDUSTRIAL TELEVISION
LANCASTER, OHIO
OFFICES IN 39 PRINCIPAL CITIES
Diamond Specialty Limited—Windsor, Ontario
Since 1903, Diamond has Manufactured Quality Equipment for Industry

7800

DIAMOND POWER SPECIALTY CORP.
ELECTRONICS DEPT., P.O. BOX 58-J
LANCASTER, OHIO

Please send me without obligation a copy of bulletin showing how Diamond Industrial (Wired) Television will help me reduce costs and improve operations.

Name_____

Title_____

Company_____

Address_____

Valve standard

Continued from page 192

formula represents something of a compromise with the best-available engineering thinking at the time.

The fortunate part is that new concepts need not disregard a standard once it is set up. They merely alter the allowable pressure rating of the series at various temperatures. For example, the 10-in. valve has a 4 9/16-in. wall thickness. If, in the years to come, a new theory of strength is developed for heavy-walled cylinders, the existing valve can still be used at somewhat higher or lower pressures to conform to the new idea. Change in wall thickness of an entire design series is not required. So any uncertainties about pressure-containing strength of very heavy-walled pipe should not prevent initial development of a standard.

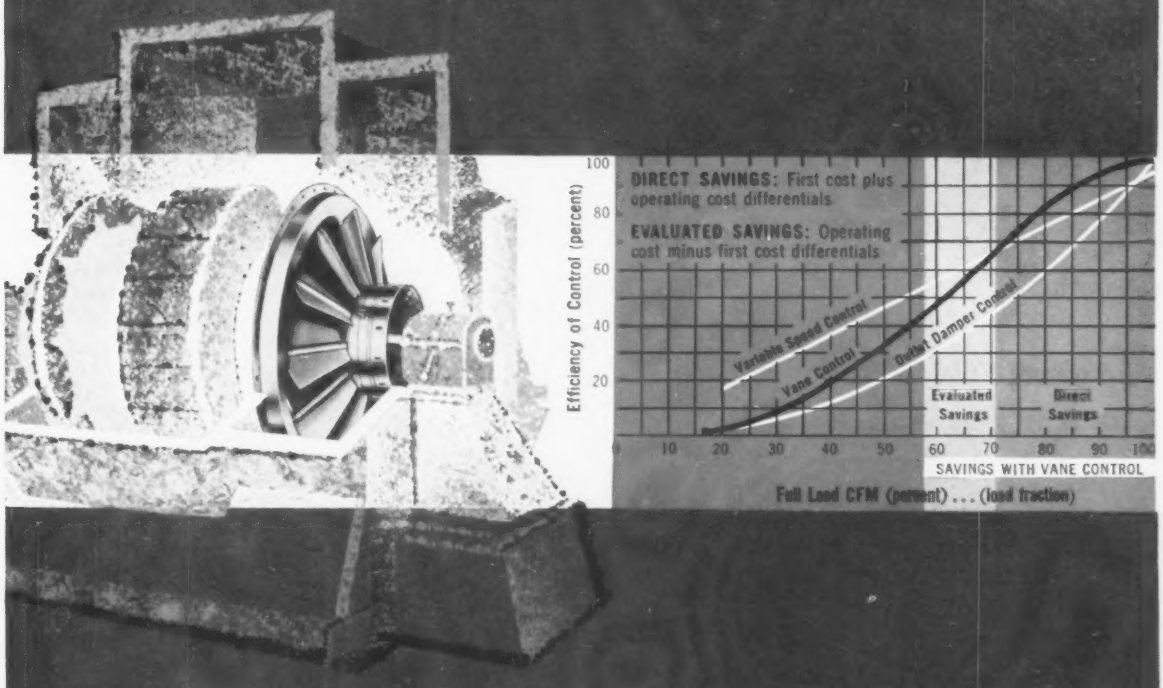
It's true that 95% of the valves for today's higher-pressure power plants can be handled with 2500-psi valves. But add to the remaining 5% the needs of petrochemical, refining, hydraulic and other such industries . . . and there is ample need for action on the 4500-psi standard *today*.

Finally, the cost to the owner must prevail as the ultimate criterion to keep design on a sound economic basis. A properly developed standard is by definition, economic for both buyers and sellers. To burden industry with an official standard that will soon prove to be timid is a mistake. Never should anyone have to look on a *new* standard as even partially obsolete.

"Why don't we just replace that coil instead of trying to fix it?"

DON'T SPEND $12,000 ON A $4,000 JOB

and still lose money on operating costs!



Westinghouse Inlet Vane Air Spin Control
is the best way to regulate forced and induced draft fan volume with constant speed motors

* Lower First Cost • * Lower Operating Costs * High Efficiency

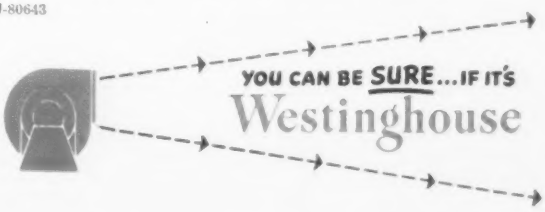
Specify this simple, reliable and mechanically foolproof regulator of fan output for your combustion control. Action is smooth. Response to exact pressure and volume requirements is instantaneous, adjustment precise.

Westinghouse Vane Control can be used on Forced and Induced Draft! Available in distinct designs for clean air forced-draft and coal-fired induced-draft applications.

Hundreds of power plants are benefiting from the economy and effectiveness of Westinghouse Inlet Vane Control on Forced and Induced Draft Fans.

Call your local Sturtevant Division Sales Engineer today, or write Westinghouse Electric Corporation, Dept. A-15, Hyde Park, Boston 36, Massachusetts.

J-80643



ROTO Hand-hole Seat Scraper

Roto Hand-hole Seat Scraper for B & W Boiler.

Eliminates tedious labor

Assures clean, tight fit

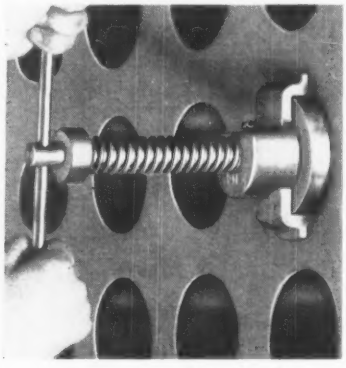
Roto Hand-hole Seat Scraper makes short work of cleaning dirty hand-hole seats. This simple, hand-operated tool has adjustable, spring-mounted retractable knives. A few turns to the right remove foreign matter without cutting the metal. A half turn to the left releases the tool, and the job is done. Customers say that the Roto Seat Scraper does the job up to 12 times faster than by any other method. Try one and you'll wonder how you ever got along without it. *Send for details.*

Now available

for most hand-hole shapes and sizes

ROUND SQUARE DIAMOND PEAR OVAL

Standard Roto Seat Scrapers are available for the following equipment. Special types made to order.



Illustrating ease of operation of Roto Hand-hole Seat Scraper.

Type of Boiler	Opening	Tube Size
Babcock & Wilcox = 4	Round	2"
" " " =41	Oval	2"
" " " =70	Round	3"
" " " =48	Oval	3½"
" " " =40	Oval	3¼"
" " " =24	Oval	4"
" " "	Oblong	4"
Bros	Round	3¼"
Casey Hedges	Oval	3½"
" "	Oval	4"
Combustion Eng'rg	Round	3"
" "	Oval	3"
Edgemoor	Oval	4"
Erie City	Ellip	2½"
" "	Oblong	3¼"
" "	Ellip	3¼"
" "	Pear	4"
Foster Wheeler	Oblong	2½"
" "	Oblong	3"
" "	Ellip	4"
Geary	Oblong	4"

Type of Boiler	Opening	Tube Size
Heine	Round	3½"
"	Oval	3½"
International Boiler 2	Oblong	3"
Keeler	Round	3½"
"	Round	4"
"	Diamond	3½"
"	Diamond	4"
Lasker	Oblong	
Murray	Oval	3½"
"	Oblong	4"
Oil City	Oval	3½"
" "	Oblong	4"
Riley Stoker	Ellip	3¼"
Springfield	Ellip	3¼"
Union Iron Works	Pear	4"
Henry Vogt	Ellip	3¼"
" "	Oval	4"
Walsh & Weidner	Oval	4"
Wickes	Ellip	2½"
"	Ellip	3¼"
"	Pear	4"
"	Round	4"

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

153 Sussex Avenue, Newark, N. J.

Welding

Continued from page 97

strain-gage instrumentation attached. A typical tube-sheet strip used in Section II and III (mounted in fixture used for simple support) is in the left background. A number of these completed assemblies are shown in the right foreground. Directly behind these and just forward of the simulated heat exchangers is one of the assemblies tested for leak tightness and pressure strength.

Section IA and IB involve a study of leak tightness and joint-strength test under fluid pressure. The two pressure vessels used are shown in Fig. 3. Note that the tube sheets, Fig. 4, are laid out to include 14 tubes each of admiralty metal, arsenical copper and aluminum brass. The first vessel with naval-brass tube sheets was welded with the automatic welding gun. Procedure for the various tube alloys is given in the welding-data table.

The test exchanger for Section I, Part B is the same as Part A, except that copper-silicon tube sheets are used.

During the halogen leak tests, both pressure containers showed gas leaks in the welded joints between the nonferrous tube sheets and the steel shells. These were then repaired and rechecked for gas leakage.

Twenty-eight joints were made (about a statistically significant number) for each tube and tube-sheet material combination. This gave a total of 168 joints in all and represents 84 joints in each of the two tube sheets.

After completion of the halogen leak tests the containers were pressurized with water. Pressure was gradually increased and at 1800 psig the tubing, subjected to external pressure, failed by collapse. No leaks developed under hydraulic test, even after mechanical failure of the tubes.

Test data analysis. Section I data show a high degree of reliability in welding copper-base alloy tubes to similar alloy tube sheets.

Number of tubes used in the test is not enough to develop any weld failures even though the minimum of 28 welds for a given materials combination is close to a statistically significant sample, (30 is usually acceptable). But, enough data is on hand

For pure, rust-free hot water, specify copper-lined heaters

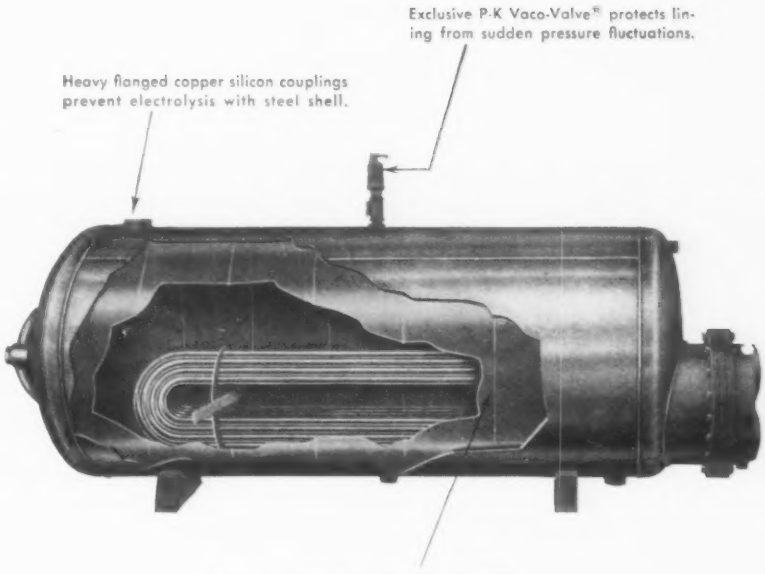
For guaranteed, trouble-free performance, specify P-K COPPER-LINED heaters

Copper-lined storage heaters assure a plentiful, pure, rust-free hot water supply. But a copper-lined water heater must also have the design and engineering features that assure long life and trouble-free service—and that's why so many engineers specify P-K Copper-lined Storage Water Heaters.

The P-K Copper-lined Heater is, in effect, two heaters in one. It is a copper shell built inside, and reinforced by, a heavy steel shell . . . combining the non-corrosive qualities of copper with the superior strength of steel. And wherever copper meets steel, the joint is protected against electrolysis by spinning copper over the tube sheet openings, or using copper silicon fittings for outside connections. Moreover, P-K testing procedures insure top operating efficiency—for every P-K Heater undergoes exacting hydrostatic and pneumatic tests that search out areas of possible failure.

In the past 40 years P-K has built more copper-lined heaters than any other fabricator. Thousands of them are installed from coast to coast, supplying users with an unfailing source of rust-free hot water and requiring only routine maintenance—proof of the soundness of P-K design and fabrication.

Put this experience to work for you by specifying P-K when you buy copper-lined hot water storage heaters. Meanwhile, get complete construction details, heating capacities, engineering and installation data by writing for P-K Data File #16 on copper-lined storage water heaters to The Patterson-Kelley Co., Inc., 2503 Warren Street, East Stroudsburg, Pa.


Exclusive P-K Vaco-Valve® protects lining from sudden pressure fluctuations.
Heavy flanged copper silicon couplings prevent electrolysis with steel shell.
Rolled expansion joints placed every 12" permit creep with temperature changes.

Patterson Kelley

3

Storage Water Heaters • Instantaneous Heaters • Convertors • Fuel Oil Heaters • Freon Chillers and Condensers

Ask the thousands of engineers who use CHESTERTON "64" STEAM PACKING

and they'll tell you...

1 "64" gives three to five times longer service because of its patented diagonal construction which permits many more "take ups" as it wears.

2 "64" stays resilient where other steam packings grow hard (because of "64"'s special heat resisting compound).

3 "64" costs less because it weighs 20% less and gives more feet to the pound (due to lighter weight of "64"'s non-vulcanizing compound).

WHICH MAKES SENSE TO YOU?

THIS:

OLD FASHION RUBBER BACK WHICH BURNS OUT

1. Has parallel plies of Asbestos which do not respond to gland or service pressure.
2. Requires a rubber back for expansion which fails on high heat.
3. Packing grows rock hard in service because of rubber cement between laminations

CONVENTIONAL PACKING HARDENS!

OR THIS:

NO WEAK RUBBER BACK

"64"

1. Has diagonal rather than parallel ply construction for self sealing action.
2. Remains soft and pliable in service because laminating compound resists hardening.
3. Old fashioned rubber back eliminated by giving expansion through patented diagonal design.

CHESTERTON "64" STAYS SOFT AND PLIABLE!

PACKING Chesterton SERVICE

You can purchase Chesterton "64" from any one of 300 local distributors. Write for catalogue and name of nearest Chesterton distributor.

A. W. CHESTERTON CO. • EVERETT 49, MASS.

America's Oldest Manufacturer of Mechanical Packings

Continued from page 196

to draw certain conclusions. These take shape as a range of values rather than a specified point at which failure might occur. Assuming that failure occurs on the next tube end welded, this range is:

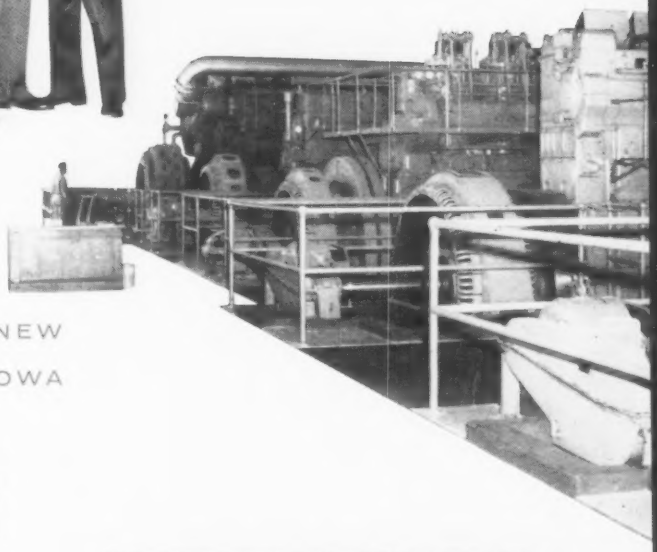
No. cases	Condition	Min	Max
28	Specific material combinations	0	2.45
84	Three tube materials, one tube sheet material	0	1.18
168	Three tube materials, two tube sheet materials	0	0.592

The validity of a test increases with its length. So we can assume the range in percent of failures for 168 cases is more nearly typical of welding than 28 or 84 cases. It's then reasonable to expect that less than 0.6% of the tubes welded will require reworking because of leakage or insufficient strength against pressure. But tube installation and welding conditions must be similar. One other factor to consider is that these tube sheets are small. Their inherent stiffness permits unusually effective swaging and mechanical working of the tubes before welding. Moreover, the test assemblies are relatively small in size and were quite easy to keep clean before and during welding. While these conditions are fairly representative of those expected during shop fabrication, they do not fully represent field conditions. In order to get equally good results (equal weld reliability) in the field, equivalent conditions of installation must be maintained.

Conclusions. Welded-tube fastenings in the various material combinations studied have excellent leak-tightness characteristics. Adequate strength against hydrostatic pressure can be consistently obtained. Reliability of the welding process in terms of leak tightness and strength against pressure is high. Less than 1% weld failures from either of these criteria may be anticipated.

Mechanical strength of the joints used approaches the specified minimum strength of the tubes welded for the combinations of admiralty metal and aluminum-brass tubes and cop-

Maybe *you'll soon have this decision to make*



LUBRICATION CASE STORY ON THE NEW WORTHINGTON AT INDEPENDENCE, IOWA

Situation: Gene Williamson, plant superintendent, had a decision to make when the Independence, Iowa, Municipal Light Plant installed a new 3600 Horsepower Dual-Fuel Worthington last year. What lubricating oil to use? Other equipment in the plant was lubricated with STANODIESEL Oil M. Performance was excellent. Lubrication technical service performed by men with experience and training for the job likewise was excellent.

What was done: The decision was made to install STANODIESEL Oil M. Now after 3,780 hours of operation, there are no regrets. There are no signs of wear.

STANODIESEL Oil M is refined from the finest-quality base stock. Additives help the oil resist viscosity change, keep engine parts clean. Other additives control foam, make it possible for oil to reach and hold protective film on even the most difficult to lubricate parts.

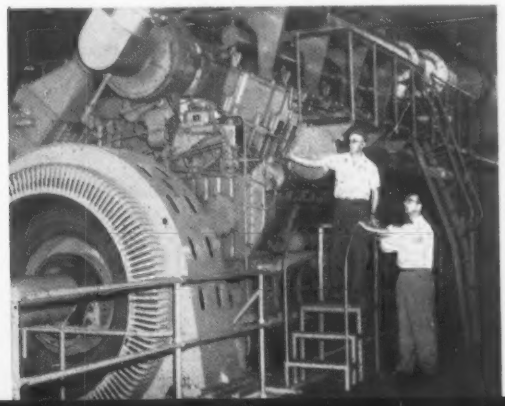
What you can do: Get all the facts about STANODIESEL Oil M from your Standard Oil lubrication specialist. There's one near you in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**

Quick facts about

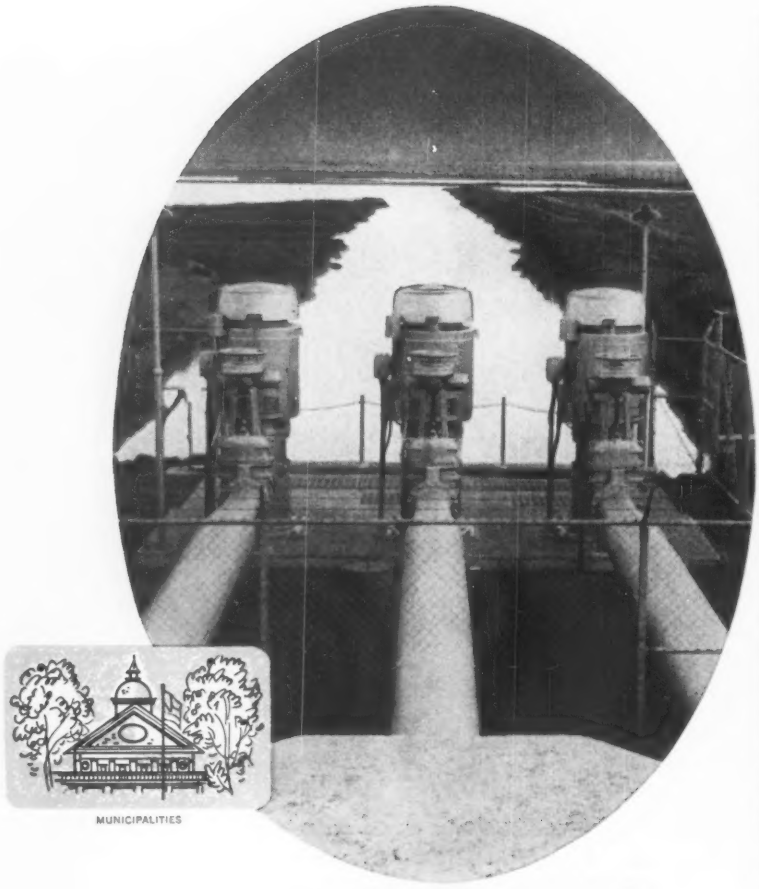
STANODIESEL OIL M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

You expect more from **STANDARD** *and get it!*



Running smoothly. Gene Williamson, power plant superintendent, and Standard Oil's Bob Wenger (right) check over new Worthington Dual-Fuel engine. Good lubrication technical service is one of the reasons Williamson decided upon STANODIESEL Oil M when engine was installed. Bob Wenger is well qualified by both experience and training to provide such technical service. He has been doing this work for nine years. In addition, he has an engineering degree from Iowa State and has completed the Standard Oil Sales Engineering School.



Verti-Line®

BOOSTER PUMPS

In

Government Service

These three 250 HP Verti-Line pumps move 36.9 million gallons of water per day from a Columbia River canal through 800 feet of concrete pipe. Verti-Line was chosen for this critical irrigation job by the Bureau of Reclamation because of proved reliability.

Over 100,000 satisfied vertical pump users agree there's no pump like Verti-Line for low first cost, economical operation, and negligible maintenance.

IF YOUR NEEDS INCLUDE BOOSTER PUMPS, IT WILL PAY YOU TO INVESTIGATE VERTI-LINE BEFORE YOU BUY.

Verti-Line Pumps are exclusive products of

LAYNE & BOWLER PUMP COMPANY
general offices & main plant
2943 VAIL AVENUE • LOS ANGELES 22, CALIFORNIA

Welding

Continued from page 198

per-silicon tube sheets. But reduced mechanical strength is the result of welding admiralty-metal tubes to naval-brass tube sheets. A further reduction is characteristic of the aluminum-brass tubes and naval-brass tube-sheet combination.

Rolling, in addition to welding, is likely to increase strength of the characteristically stronger joints associated with copper-silicon tube sheets. It's less likely to contribute to the strength of the characteristically weaker joints associated with naval-brass tube sheets.

Second part of this 3-part article will delve into data on tube-sheet distortion in Sections II and III of the test program. The third part will cover various tests on the special heat-exchanger assembly made under simulated conditions of manufacture.

Transistors

Continued from page 109

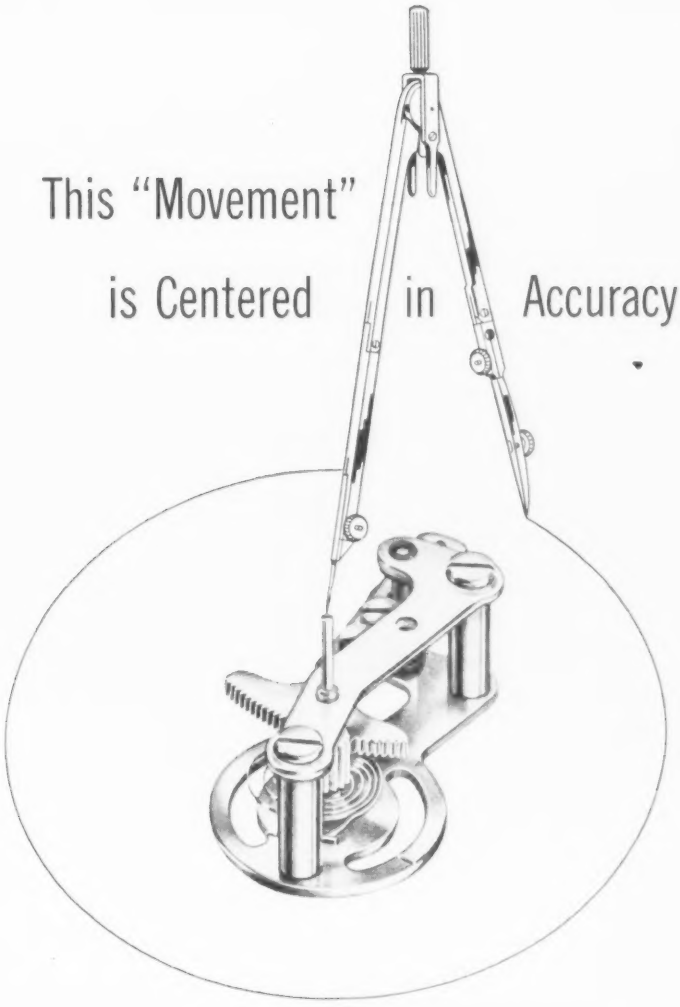
problems should be called to his attention.

Interference or "pickup" is another problem; one which many times escapes proper notice. It's caused by electric arcs from furnaces, relays, switches, etc, or apparatus using carrier currents on the power lines, such as remote controlled cranes, valves, etc. Suitable simple filters in the incoming power lines and proper shielding of wires in conduit will usually fix this up. Again this is no real detriment, but simply good installation practice.

Reviewing the overall picture, you have only to consider what is happening in our rapid technological expansion. You could service a Model-T Ford with a staunch pair of pliers, a screwdriver and an occasional piece of wire. A reputable mechanic, however, would not think of working on the automatic transmission of a 1958 model without learning how it works and equipping himself with the proper torque wrenches, gages, etc.

The whole question of transistor installation and maintenance can be adequately simplified by intelligent first design and proper application, coupled with educated maintenance men who know how the equipment works and appreciate its peculiarities.

This "Movement" is Centered in Accuracy



The rotary movement in Ashcroft Duragauges has a geared center shaft on which the pointer is mounted. When pressure flexes the Bourdon tube, the pointer is always positively positioned. You can rely on the Duragauge for precise accuracy in measuring pressure no matter how severe the conditions of service.

Correct calibration is guaranteed: the one-piece link between movement and Bourdon tube prevents slippage or parting under tension. Recalibration is easy from front or rear. Universal adjustability permits uniformly graduated dials.

You can order Ashcroft Duragauges with all-stainless-steel movement or stainless steel with nylon bearings and pinion gear. A complete choice of Bourdon tube materials, pressure ranges, dial sizes and case designs and materials is available. Your industrial supply distributor will gladly help you select the best combination for your requirements. So, be certain of highest sustained accuracy, durability and economy – specify Ashcroft Duragauges.

Ashcroft Duragauge in Alumalife® case—a lifetime case made of special aluminum alloy.

MAXWELL MANNING M&M & MOORE, INC. TRADE MARK

ASHCROFT PRESSURE GAUGES

A product of

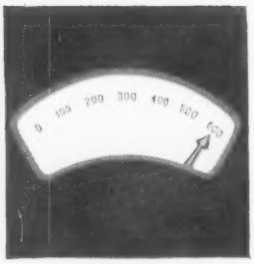
MANNING, MAXWELL & MOORE, INC.

Consolidated Ashcroft Hancock Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

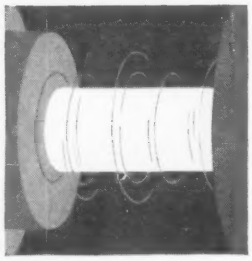
G1-58

HIGH TEMPERATURES



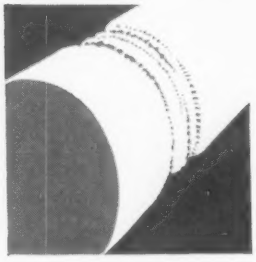
You want pump packings which will hold up under temperatures to 600°F . . .

LOTS OF FRICTION



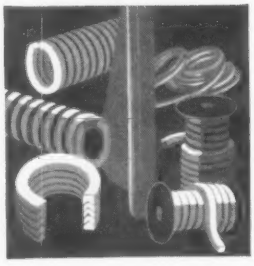
. . . packings whose lubricants will not go up in smoke when the heat and speed are on . . .

ADD UP TO TROUBLE UNLESS . . .



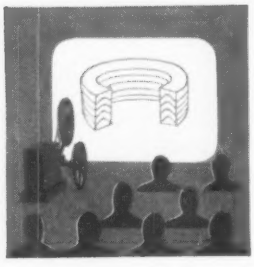
. . . because improper packing materials can cause costly damage to parts, interfering with your production.

. . . YOU USE R/M BIG 7 PACKINGS



R/M Universal Plastic Packings, one of the Big 7 Packing Types, give you longer, more dependable performance, because lubricant goes all the way through, and because they contain no organic fibers which burn up.

SEE "I AM A PACKING"



Color movie is part of R/M Packing Clinic. Learn how three or four R/M Big 7 Packing Types may meet 95% of your needs. Ask your authorized R/M distributor for a showing!

R/M

BIG 7 PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, PASSAIC, N.J.

MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings Brake Blocks • Clutch Facings • Industrial Adhesives • Bowling Balls • Laundry Pads and Covers

I-c engines

Continued from page 93

3*a*. We can relate peak state to the inlet state as follows:

1. Compression ratio $= V_r = \frac{V_1}{V_2} = \frac{V_B}{V_5}$
2. Temperature ratio $= T_r = \frac{T_5}{T_1}$
3. Pressure ratio $= P_r = \frac{P_5}{P_1}$
4. From Boyle's law since $T_B = T_5$
5. $P_B V_B = P_5 V_5$
6. $\frac{P_5}{P_B} = \frac{V_B}{V_5} = V_r$
7. From Charles' law since $V_B = V_1$
8. $\frac{P_B}{P_1} = \frac{T_B}{T_1} = \frac{T_5}{T_1} = T_r$

Combining (6) and (8)

9. $\frac{P_5}{P_B} \times \frac{P_B}{P_1} = V_r \times T_r$
10. $P_r = V_r T_r$

Next part will cover effect of varying compression ratio and water-jacket cooling of the Otto engine—in a forthcoming issue.

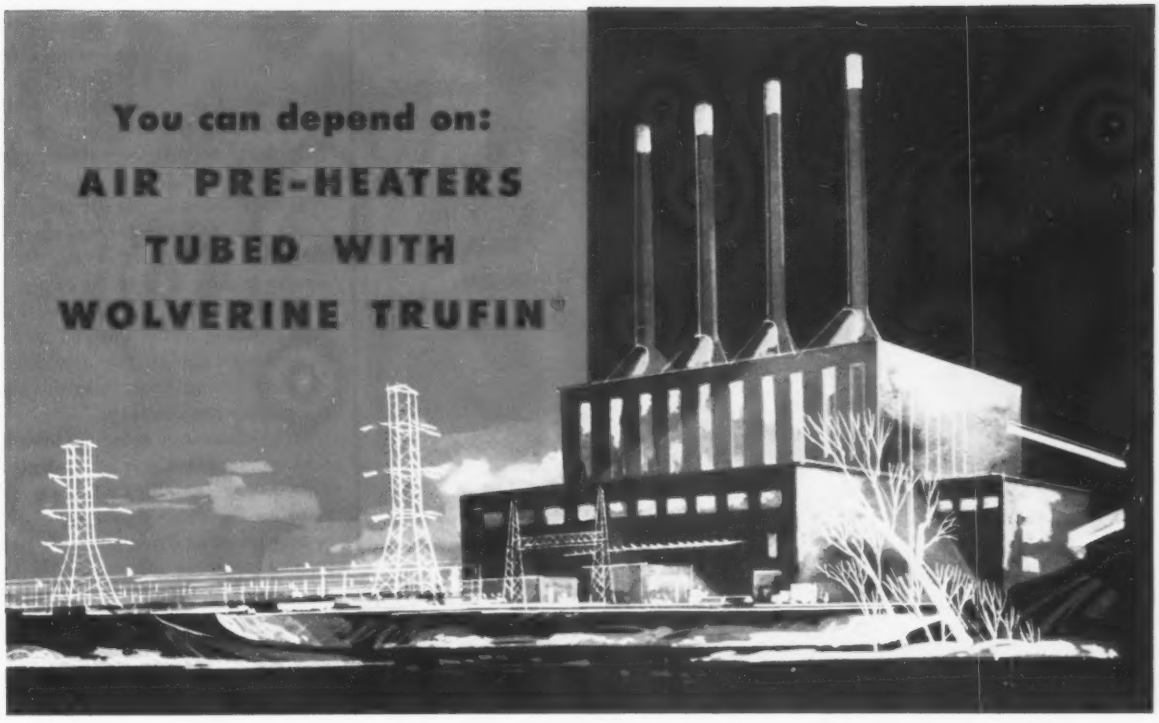
Condensers

Continued from page 99

There are several ways to remove deposits from the inside of the tubes. If condenser can be taken out of service for a weekend or longer, dry the tube surfaces by draining the condenser and leaving all inspection doors open. If deposit is muddy or organic, some of it will crack and scale off. Loosened material is then washed away by the first water passing through the condenser.

"Shooting" rubber plugs through the tubes with compressed air removes algae slime and mud deposits. For scale or tenacious slime, a scraper plug, designed to more effectively cut through the scale or slime may be successful. A slower method, suitable for small condensers where the entire head is removable, is to use a wire brush on a long handle.

Men must get into the condenser waterboxes to do the work in the last two methods described above. With some natural waters, as from sewage-polluted rivers, this becomes unpleasant. Also, stiff brushes or me-

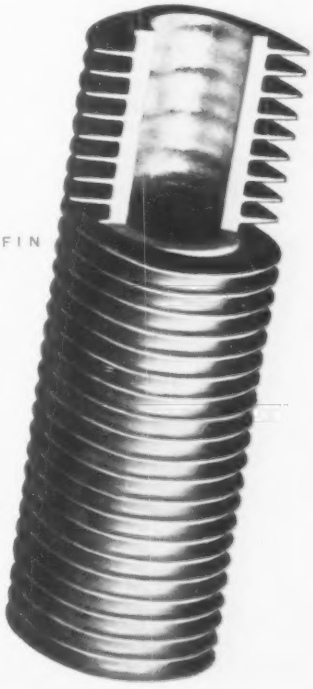


In many modern plants, engineers are gaining greater efficiency by specifying integrally finned Wolverine Trufin for use in combustion air pre-heaters.

The pre-heaters, currently going into a large power plant using other aluminum condenser tubes, are tubed with weight-saving aluminum Trufin Type H/A. This tube is also available in copper.

Wolverine Trufin Type H/A has an outside to inside surface ratio of approximately 8:1. In this particular case, with pure condensing steam inside the tube, air is raised from 80°F. to 180°F. prior to entering the stack heaters.

If your company is contemplating the construction of a new power plant—or is expanding or modernizing—don't finalize pre-heater design until you get complete information about Wolverine Trufin and its benefits. Ask for the services of a Wolverine Technical Representative and write, too, for a free copy of the Trufin Catalog.



WOLVERINE TRUFIN
TYPE H/A

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

CALUMET & HECLA, INC.:
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION

In Canada:
CALUMET & HECLA OF CANADA LIMITED
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
UNIFIN TUBE DIVISION

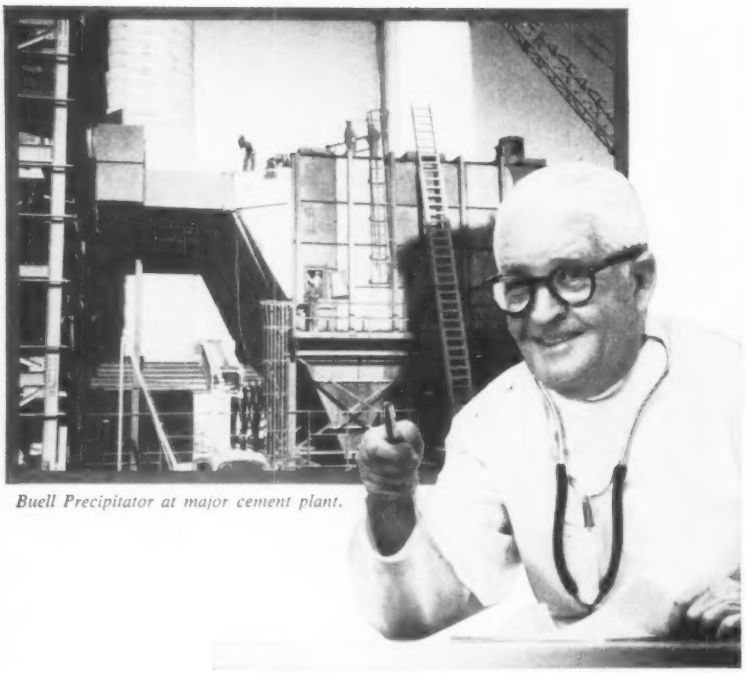
WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17268 Southfield Road
Allen Park, Michigan

Manufacturers of Quality Finned Tubing and Extruded Aluminum Shapes

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

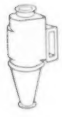
EXPORT DEPT., 11 E. 40TH ST., NEW YORK 16, N.Y.



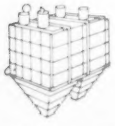
Buell Precipitator at major cement plant.

Specialists in treatments for the flue

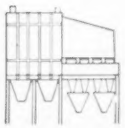
Hundreds of installations have proved the extra efficiency of Buell Dust Collection Systems. In mechanical collectors, only Buell cyclones have the exclusive Shave-off that traps an extra percentage of dust, large-diameter design that eliminates bridging and clogging. In electrical collectors, only Buell "SF" precipitators have features like high-emission, failure-proof Spiralectrodes. The results are high collection efficiency, freedom from shut-downs, minimum or no maintenance year after year in every Buell installation. Get the full story in "The Collection and Recovery of Industrial Dusts." Write Dept. 50-C, Buell Engineering Company, Inc., 123 William Street, New York 38, New York.



BUELL CYCLONE



"SF" ELECTRIC PRECIPITATORS



PRECIPITATOR-CYCLONE COMBINATION

buell®

Experts at delivering Extra Efficiency in

DUST COLLECTION SYSTEMS

Condensers

Continued from page 202

tal scrapers introduce the possibility of scratching the tube surfaces. Unduly rapid erosion or corrosion may result.

If the condenser has divided waterboxes, one half can be cleaned while the other half is in service. By reducing turbine load to ¾ or ½ normal, vacuum is not affected too much. Men working in the waterboxes must be protected against the possibility of someone letting water into the space where they are working.

Acid cleaning, using an inhibited acid, removes scale or other deposits. This involves handling a large quantity of acid and the possibility of corroding tubes or steel condenser parts. It also requires adequate and safe means for venting the hydrogen gas that is released as the scale is dissolved. Plant personnel may be able to perform this operation, but it is usually more advisable to call in a competent organization with the required experience and special equipment needed—at least for the first few times.

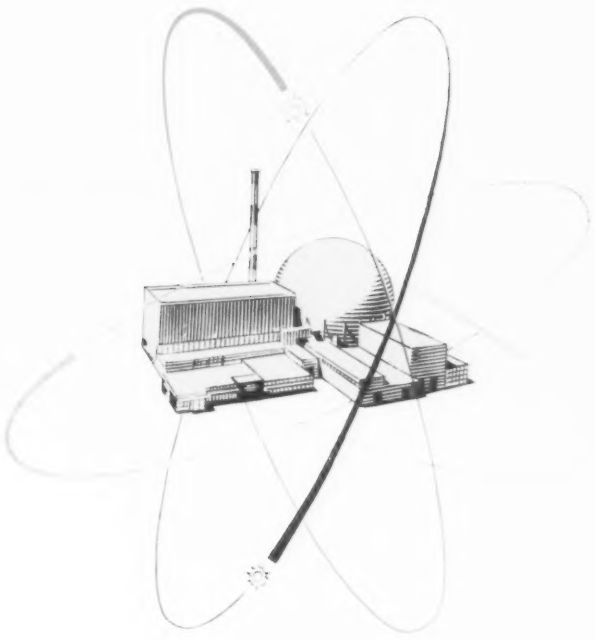
Condenser cleaning is costly and unpleasant no matter how it is done. It is generally more economical to prevent the deposits than to remove them after they are formed.

A close physical inspection of condenser tubes reveals the extent of deposits. But remember that near the tube ends, turbulence may keep deposits from settling, and further along the tubes they are difficult to see. Also, some scale formations are difficult to detect because they are smooth and transparent.

A more accurate way to check tube cleanliness is to calculate the unit heat-transfer rate expressed as Btu per sq ft per hr per degree of logarithmic temperature difference. Checking against guaranteed performance curves reveals the departure from guaranteed performance. You can then estimate when the saving in steam, resulting from better vacuum, will equal the expense of cleaning the condenser, including the outage time required.

The terminal difference—that is, the difference between temperature of exhaust steam and outlet circulating water, gives a quick check of condenser performance. If load and circulating-water temperatures and

(*Continued on page* 210)



LADISH

IS THE FIRST NAME IN

Controlled Quality

PIPE FITTINGS FOR

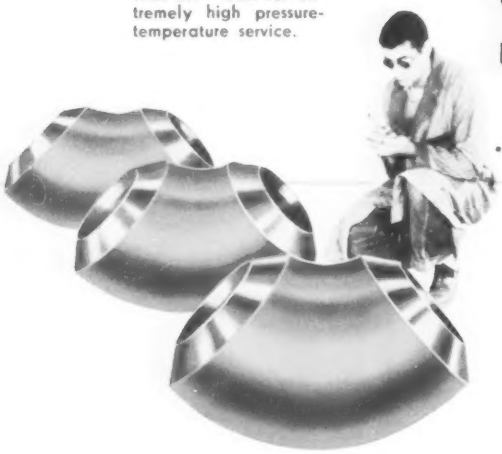
NUCLEAR AND CONVENTIONAL

POWER INSTALLATIONS

LADISH

...THE RECOGNIZED, DEPENDABLE SOURCE FOR

18" alloy steel elbows with 3.9" wall for extremely high pressure-temperature service.



Heavy wall laterals closed impression die forged of Stainless Steel in a variety of sizes.

Stainless Steel, heavy wall, reducing tee with extended run section.

Stainless Steel Elbow with heavy wall and special radius for nuclear service.

Seamless and welded rolled rings produced in sizes to 20 feet in diameter . . . in rectangular and contour cross sections . . . in all forgeable material specifications . . . to meet critical requirements of reactor installations.

16" x 16" x 20" forged Chrome-Moly bull-head tee with special flow dividing throat section opposite the branch.

Heat exchanger tube sheet of Stainless Steel. Forged weight — 4220 pounds.

Unusual Fittings

FOR NUCLEAR AND CONVENTIONAL POWER PIPING APPLICATIONS

Ladish is widely recognized as a prime, dependable source for a broad range of special-purpose fittings and forgings to meet unusual piping problems.

The fittings shown here were developed in close collaboration with the engineering staffs of firms pioneering in the design of modern conventional power plants and nuclear power installations.

Ladish has extensive experience and unequalled facilities for forging, machining and testing . . . small and large, simple and complex parts, in virtually every forgeable material . . . under precise metallurgical and manufacturing controls.

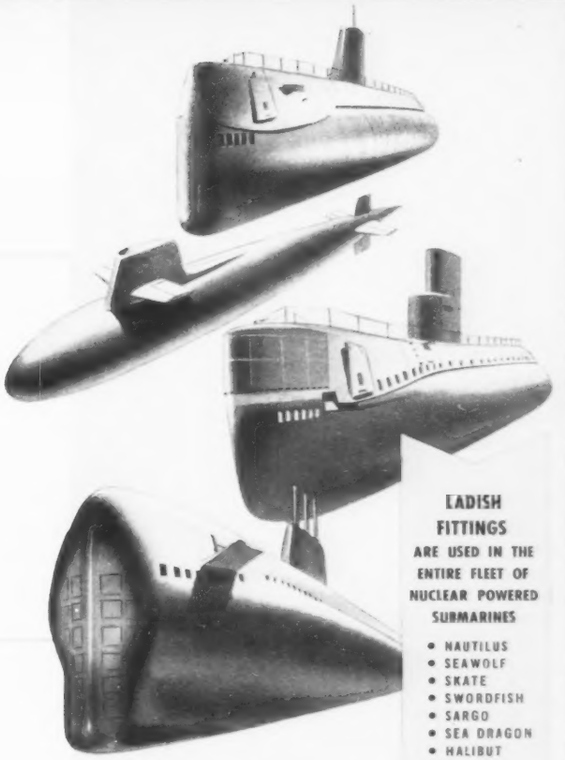
Type 304L Stainless Steel Nozzle, drop forged and machined to precision tolerances.

Titanium pipe fittings produced for a number of critical piping installations requiring positive resistance to extremely corrosive media.

Largest closed impression die forging produced to date. Weight — 10,500 pounds . . . 316 Stainless Steel. For use in modern power plants operating at elevated pressures and temperatures.

TO MARK PROGRESS

Intricately shaped Stainless Steel heat exchanger heads. Drop Forged and machined to close tolerances by Ladish.



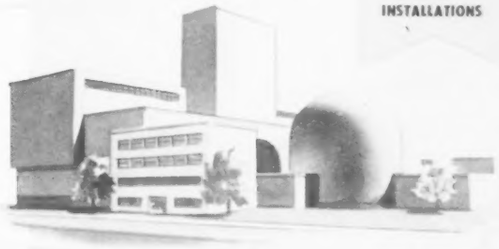
LADISH FITTINGS ARE USED IN THE ENTIRE FLEET OF NUCLEAR POWERED SUBMARINES

- NAUTILUS
- SEAWOLF
- SKATE
- SWORDFISH
- SARGO
- SEA DRAGON
- HALIBUT
- SKIPJACK
- TRITON

...AND IN PROTOTYPE REACTOR SYSTEMS FOR SURFACE SHIPS

HANFORD • OAK RIDGE • ARGONNE
LOS ALAMOS • PADUCAH
DRESDEN • SANTA SUSANA • DETROIT
SAVANNAH RIVER • PORTSMOUTH
NATIONAL REACTOR TEST STATION
SHIPPINGPORT • BROOKHAVEN

LADISH CONTROLLED QUALITY FITTINGS IN A.E.C. NUCLEAR REACTOR INSTALLATIONS



LADISH CO.

CUDAHY (Milwaukee Suburb) WISCONSIN

Serving the West . . . Ladish Pacific Division, Ladish Co., Los Angeles, Calif.
Serving Canada . . . Ladish Co. of Canada Ltd., Brantford, Ontario

Complete Service in *Controlled Quality* Fittings

WELDING FITTINGS	ASA & MSS FLANGES	SCREWED and SOCKET FITTINGS and UNIONS	LONG NECK FLANGES	TEMA & LARGE O.D. FLANGES & ROLLED RINGS

THESE AND OTHER FITTINGS ARE PRODUCED BY LADISH TO MEET THE UNUSUAL REQUIREMENTS OF MODERN POWER GENERATION.

PRODUCED TO OPTIMUM STANDARDS OF METALLURGICAL INTEGRITY AND MANUFACTURING QUALITY...

Outstanding reliability . . . a distinguishing feature of Ladish fittings . . . is the direct result of a combination of skilled craftsmen, Controlled Quality methods, unmatched laboratory and production facilities.

Each step in production from initial verification of material analysis through final inspection is controlled by an extensive staff of quality-conscious metallurgists and engineers.

This continuous painstaking control of production processes assures metallurgical integrity and conformity to specifications.

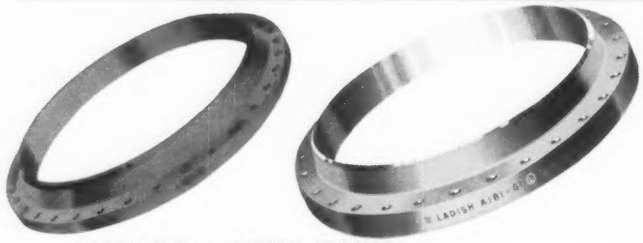
LADISH *Controlled Quality* PIPE FITTINGS

CARBON STEELS • ALLOY STEELS • STAINLESS STEELS • ALUMINUM
TITANIUM • INCONEL • AND WIDE RANGE OF FORGEABLE MATERIALS

IPS BUTT WELDING FITTINGS—½" thru 42"—Sch. 5S thru 4" walls

TUBE O.D. WELDING FITTINGS—½" thru 36"—.049" thru .250" walls

ASA and MSS FLANGES—½" thru 24"—150 lb. thru 2500 lbs.



LARGE O.D. and TEMA FLANGES—
Up to 20' in diameter

LONG WELDING NECK FLANGES—
1" thru 24"—150 lb. thru 2500 lbs.

SCREWED and SOCKET TYPE FITTINGS and UNIONS—⅛" thru 4"—150 lb. and 2000 thru 6000 lbs.

LADISH CO.

CUDAHY (Milwaukee Suburb) **WISCONSIN**

Serving the West: **LADISH PACIFIC DIVISION, LADISH CO.,** Los Angeles, Calif.

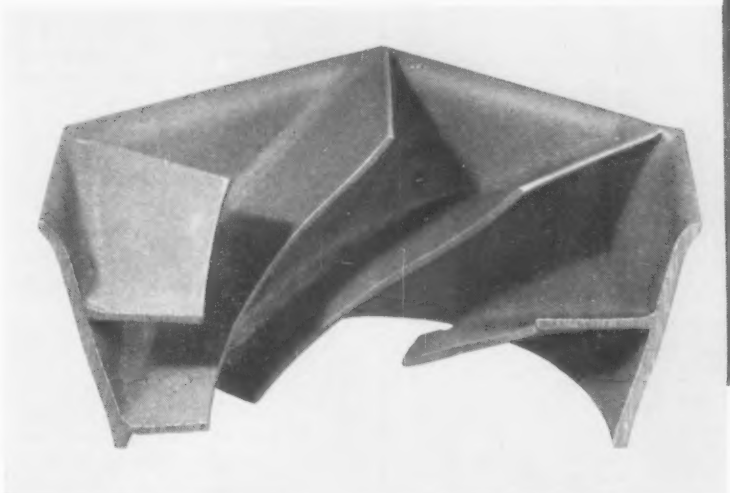
Serving Canada: **LADISH CO. OF CANADA LTD.,** Brantford, Ontario

Sales Offices:

• AMARILLO	• CALGARY	• DENVER	• MILWAUKEE	• PHILADELPHIA	• SAN FRANCISCO
• ATLANTA	• CHARLOTTE	• HOUSTON	• MONTREAL	• PITTSBURGH	• SEATTLE
• BATON ROUGE	• CHICAGO	• LOS ANGELES	• NEW YORK	• ST. LOUIS	• TORONTO
• BUFFALO	• CLEVELAND	• MEXICO CITY	• ODESSA	• ST. PAUL	• TULSA

HAGAN
DUST COLLECTOR CUTS COSTS

...of air pollution control
...of product recovery



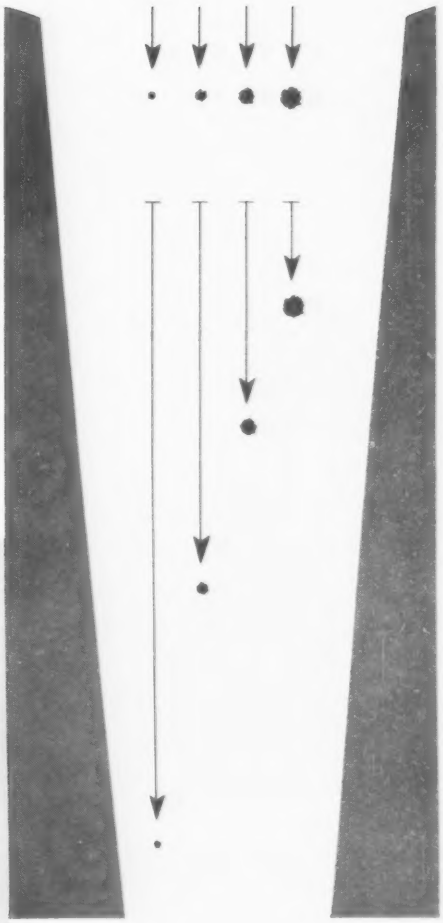
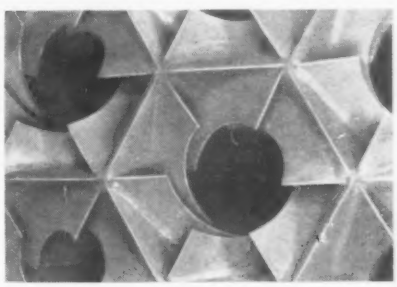


Diagram shows how Selective Particle Acceleration works. Venturi effect of individual inlets accelerates gases on a 6 to 1 ratio. The larger, most abrasive particles pick up the least speed—smaller particles are accelerated the most. All are efficiently separated, but wear on tubes is sharply reduced.

The Hagan Aerostatic is the only mechanical dust collector with Selective Particle Acceleration. This unique feature increases efficiency so that it approaches that of electrostatic precipators, and reduces tube erosion to the vanishing point.



Detail of tube assembly. Note Hexagon shape of tops—there are no flat surfaces, so it is impossible for dust to accumulate and clog tubes.

Here are the facts on SELECTIVE PARTICLE ACCELERATION:

The patented, spiral inlet vane ports have a decreasing cross-sectional area—in effect—a venturi. Gases moving through the ports increase to 6 times their velocity within a space of only three inches.

Small particles (1 to 10 micron range), having very little inertia, are accelerated rapidly, approaching stream velocity.

Larger particles, with more inertia, pick up speed more slowly. They are collected with the same high efficiency, but at low velocity.

Result—the full range of particle sizes are efficiently collected, but the larger and more abrasive particles move at speeds that reduce abrasion drastically.

Write for Descriptive Bulletin MSP 124 A. It contains a complete description of the economical and efficient Hagan Aerostatic Dust Collector.

HAGAN CHEMICALS & CONTROLS, INC.

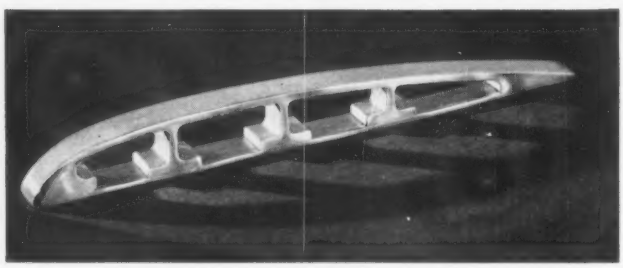
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

Boiler Tube Service

fast
— call these representatives
PITTSBURGH Boiler Tube Co. of America Federal 1-7750
CLEVELAND Boiler Tube Co. of America Yellowstone 2-6105
CHICAGO Boiler Tube Co. of America State 2-7955
PHILADELPHIA Raphael Paul Lombard 3-7700
LOS ANGELES Fred S. Renauld & Co. Pleasant 2-6181
TAMPA John D. Homan Tampa 65-7211
ATLANTA E. W. Harbour (College Park) Fairfax 1374
ROANOKE J. J. Bower Roanoke 6-3474
NEW ORLEANS Factory Sales & Engineering Canal 9151
HAVANA, CUBA Wm. P. Bryant M-9284
SAN JUAN, P.R. F. A. Ortez & Co. 2-4934
5

BOILER TUBE
COMPANY OF AMERICA

McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750



Cross section shows structural superiority of Aeromaster's new, extruded aluminum-alloy blades in diameters from 9' to 22'.

NEW! EXTRUDED ALUMINUM Blades on AEROMASTER* fans only

AEROMASTER'S new, extruded aluminum blades combine in one design the advantages of a light weight metal, a hollow structure and the superior strength of wrought metal... Silicon-magnesium aluminum alloys resist corrosion. Their fine grain structure, high tensile strength and increased endurance limit eliminate danger from wear, vibration, and metal fatigue . . . true airfoil blade sections assure maximum air delivery . . . adjustable blade pitch angle permits decrease of fan load to an accurate minimum horse-power requirement.

The AEROMASTER fan is easily assembled *in the tower.* No special handling equipment is necessary. AEROMASTER fans cost less to install, less to operate, less to maintain!

For more details write to KOPPERS COMPANY, INC., Aeromaster Fan Dept., 2603 Scott Street, Baltimore 3, Maryland.

*Koppers Trademark

KOPPERS

Aeromaster Fans

Engineered Products Sold with *Service*

Condensers

Continued from page 204

quantities are about normal, terminal difference furnishes a good check. A good heat-transfer rate in a condenser is unlikely if the terminal difference is greater than 6 F, except with extremely cold water.

Air leakage. Any of the above checks on condenser performance should be made with fairly low air leakage. Leakage beyond the capacity of the air pumps affects condenser performance adversely even if condenser tube surface is clean.

To determine whether the condensing system is tight enough, it is helpful to measure the amount of air pumped. Do this by passing the air through an orifice or other low-resistance form of metering device. The pressure resulting gives a measure of air being removed from the condenser.

A good tight system has only 1 or 2 cfm leakage; a poor but passable one may have 5 to 10 cfm leakage. More leakage than this usually exceeds pump capacity, and condenser performance is affected by the partial pressure of the air remaining in the condenser.

A low pumping rate does not necessarily mean that vacuum is as good as possible, however. If pump capacity is limited because of jet stoppage, recirculation or improper steam or water operating pressure, air pressure in the condenser steam space builds up. Eventually there is so much air in the air-vapor mixture entering the pump, that pump is able to equalize air removed with air entering the system.

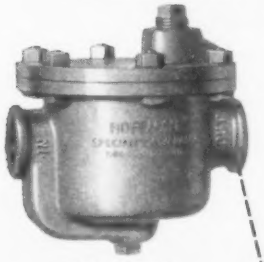
A good test is to shut off the suction line from the condenser and determine the highest vacuum the pump will produce. Varying steam or water-jet pressure shows point of best vacuum. Best operating pressure is usually a little higher than this, because the steam flow at highest vacuum point will not handle maximum air leakage. If quantity of air pumped is low and the pump can produce a high vacuum, you are probably getting the best condenser vacuum possible for the circulating-water temperature and quantity available, amount of steam to be condensed, and the condition of the heat-transfer surfaces.

Water flow. For the usual summer, spring and fall water temperatures, and for fairly heavy loads, it

HOFFMAN STEAM SPECIALTIES

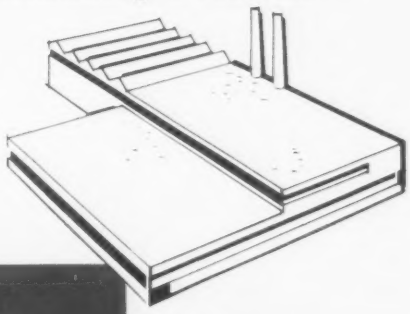
Designed and Engineered to Meet Industry's Needs

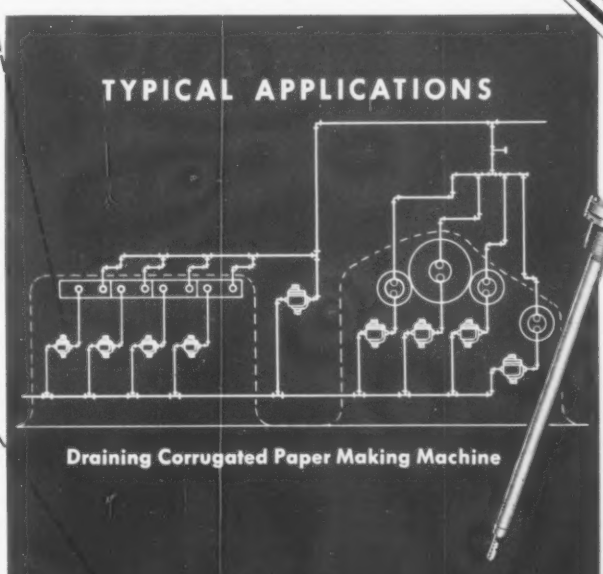
- Heating Systems
- Manufacturing
- Processing



600 SERIES
INVERTED BUCKET TRAP

For draining condensate and air from equipment such as: steam cookers, steam heated vats in process work, unit heaters, steam coils, pressers, corrugated paper making machines and for lifting condensate to overhead return mains.





TYPICAL APPLICATIONS

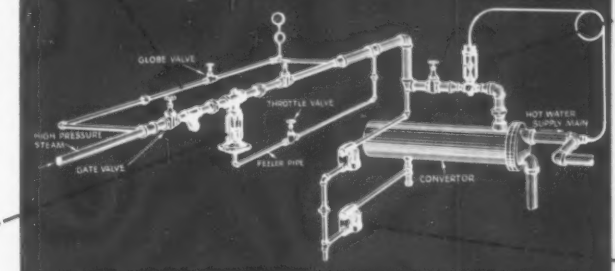
Draining Corrugated Paper Making Machine

400 SERIES DIRT STRAINER

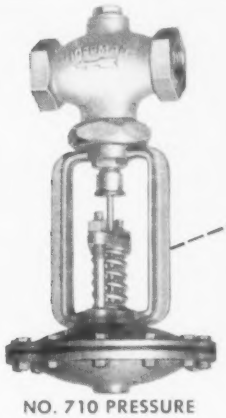
To protect valves, traps and pumps from damage caused by dirt, rust and scale. For use on steam, water, oil or gas service.

SERIES
1110
TEMPERATURE
REGULATOR

To regulate supply of steam to the heating coils in converters, cookers, processing tanks, sterilizers and water heaters.

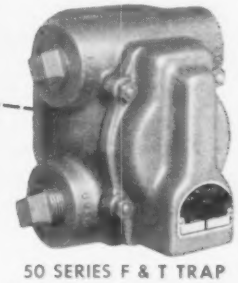


Converter for Heating Water with High Pressure Steam



NO. 710 PRESSURE
REDUCING VALVE

To reduce the pressure of fluids from a higher initial pressure to a lower second pressure. Designed to meet varying requirements necessary to control fluids, such as steam, air, oil or gas.

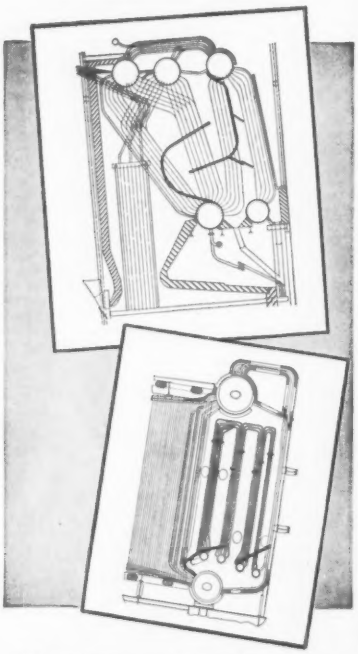


50 SERIES F & T TRAP

To release condensate and air and to prevent release of steam in steam systems. Extremely quiet in operation therefore, ideal for schools, hospitals, churches, offices and apartments.

HOFFMAN
SPECIALTY MFG. CORP.
1700 West 10th Street, Indianapolis 7, Indiana

ONLY ENCO BAFFLES give you all these COST CUTTING FEATURES



These important fuel-saving maintenance-reducing features are obtainable with Enco boiler baffles—*and only with Enco baffles.*

- **Streamlined gas flow**
- **Uniform gas flow**
- **Elimination of bottlenecks**
- **Reduced draft losses**
- **Higher heat transfer**
- **Cleaner heating surfaces**
- **Less use of soot blower**
- **Special provision for expansion**
- **Easy tube replacement**
- **Adaptable to any water-tube boiler, fired by any fuel**

Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.

THE ENGINEER CO.

75 WEST STREET, NEW YORK 6, N.Y.

In Canada: Rock Utilities Ltd., 80 Jean Talon St. W., Montreal, P. Q. EC-506

Condensers

Continued from page 210

is economical to put all available circulating water through the condenser. But, when water temperature falls, there may be economy in shutting down one or more circulating pumps, particularly if steam load is low. While vacuum may fall a little, the loss in turbine economy may be considerably less than the saving in auxiliary power.

If curves for condenser performance, circulating-water pump performance and turbine vacuum corrections are available, you can calculate the approximate point where reduction in circulating-water flow is economical.

If turbine governor can be set for constant steam flow, the actual change in generator output as circulating-water flow is reduced can be noted and compared with the reduced power used by the pumps. After temperatures stabilize, you need only a few seconds to count revolutions of the kwhr integrating meter and thus determine generator output quite accurately.

Power consumption of one pump usually increases a few percent as pump in parallel with it is shut down. The reduced flow in the condenser system cuts the head against which the pump operates. Depending on the pump characteristic curve, the water pumped and power used will change. A permanent wattmeter or ammeter, or a clip-on ammeter, measuring power to circulating-water pumps, indicates the change in total power required for pumping.

Free literature

Begins on page 171

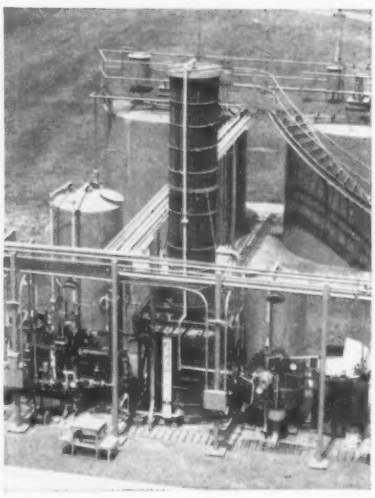
trates features, design and construction details. Allis-Chalmers Mfg Co, Milwaukee 1, Wis.

11 **Power panelboard,** heavy-fusible type incorporating rigidly mounted quick-make quick-fusible switch units, is subject of 4-p bulletin GEC-1382A. Lists features, application data, selection information. Distribution Assemblies Dept, General Electric Co, Plainville, Conn.

12 **Potheads** are described in 12-p catalog 5703. Covers single- and three-conductor cable-sealing devices for indoor and outdoor service. Includes cutaway photos, drawings. Delta-Star

ILLCO-WAY

ionXchange



"SILICA: 0.003 PPM, OTHER SOLIDS UNMEASURABLE..."

With some doubt as to the outcome, the de-ionization units pictured above were installed outdoors at a Texas power and light company, to replace evaporation equipment as a means of purifying feed water for a high-pressure boiler. After three years, results far exceeded guarantee and expectations. From raw water containing 27 ppm of silica and dissolved solids totaling 365 ppm, the quality of the effluent is reported as: "Silica, zero to 0.005 ppm, average 0.003 ppm. Other solids are unmeasurable."—This is a good example of what modern ILLCO-WAY ionXchange can accomplish.

BOILER FEED WATER FOR POWER PLANT

The particular plant shown above consists of a cation exchanger, an aerator, and a mixed-bed deionizer. The large tanks in the background hold a supply of regenerants. Operation is manual throughout, a preference of the purchaser. *Results have proved even more economical than expected.*

ionXchange

ILLINOIS WATER TREATMENT CO.

ILLCO-WAY

840 CEDAR ST.
ROCKFORD,
ILLINOIS

NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

THE PEACEFUL ATOM

...takes a big step forward

Formal Dedication of the Sodium Reactor Experiment Marks Significant Milestone in Nuclear Power Program

On November 14, 1957, in a building high in California's Santa Susana Mountains, a group of people witnessed a ceremony of great significance not only to America, but to mankind everywhere. What they saw was the official confirmation of the success of the sodium graphite type of nuclear reactor as a most promising new method of increasing resources of usable power in a power-hungry world.

They were watching the formal dedication of the Sodium Reactor Experiment, designed and built for the Atomic Energy Commission by Atomics International. The SRE includes an experimental atomic power reactor, which achieved sustained nuclear fission in April, 1957. In July reactor heat was used to generate electricity. The SRE has been performing as planned, supplying data on the practical aspects of designing and operating a power station based on the Sodium Graphite Reactor. The power produced by the SRE is being delivered for use to the homes and factories of the nearby San Fernando Valley. It was the first electricity ever to be supplied to the American public by a private utility from a non-military nuclear reactor.

NUCLEAR-POWERED SPARK
A switch is thrown at the dedication of the Sodium Reactor Experiment—and electricity from the atom surges into the lines of a private utility company

THE ATOM GOES TO WORK IN SOUTHERN CALIFORNIA
In the rugged Santa Susana Mountains near Los Angeles, the Sodium Reactor Experiment is showing great promise as a practical source of electric power.

Basis for Large Power Stations

Atomics International designed the SRE to give a maximum output of about 6500 electrical kilowatts. This nuclear power plant is now in operation as part of the Atomic Energy Commission's program to develop efficient types of reactors to meet the growing worldwide need for power. Atomics International will use data from the SRE to design and construct large power stations like the 75,000 kilowatt plant planned for the Consumers Public Power District of Nebraska.

The Southern California Edison Company cooperated with Atomics International by providing a generating plant to turn the nuclear reactor heat energy into electricity and by distributing the power to its customers.

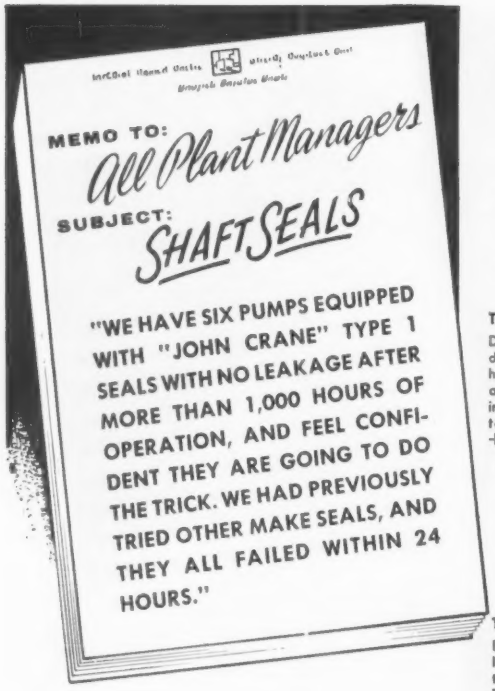
Other Achievements by AI

Another nuclear power approach being conducted by Atomics International for the Atomic Energy Commission is the Organic Moderated Reactor Experiment in Idaho, which has been operating since last September. This project will provide technical information for the construction of two 12,500 kw power stations—one in Piqua, Ohio; the other in a Latin American country. AI recently completed a study for the AEC's Maritime Reactors Branch which indicated that the OMR has technical and economic promise as a power plant for atomic supertankers and merchant ships.

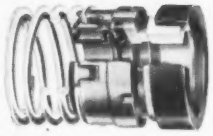
Another power reactor concept, the Advanced Epithermal Thorium Reactor, is under study for the Southwest Atomic Energy Associates. AI research reactors are now operating in Japan, Germany, Denmark, and the United States. Others are being built for Italy and West Berlin.

ATOMICS INTERNATIONAL, P.O. Box 309, Canoga Park, California. Cable Address: ATOMICS.

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM

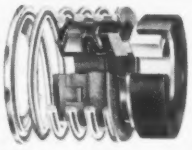

MEMO TO:
All Plant Managers
SUBJECT:
SHAFT SEALS
"WE HAVE SIX PUMPS EQUIPPED WITH "JOHN CRANE" TYPE 1 SEALS WITH NO LEAKAGE AFTER MORE THAN 1,000 HOURS OF OPERATION, AND FEEL CONFIDENT THEY ARE GOING TO DO THE TRICK. WE HAD PREVIOUSLY TRIED OTHER MAKE SEALS, AND THEY ALL FAILED WITHIN 24 HOURS."

John Crane®



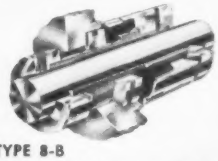
TYPE 1

Designed for limited stuffing box diameter. Handles water, light hydrocarbons, refrigerants, mild acids and other liquids non-injurious to synthetic rubber at temperatures from −40°F. to +212°F., pressures to 200 psi.



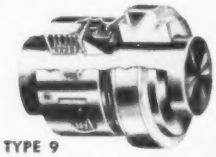
TYPE 2

Designed for limited stuffing box length. Handles same services, temperatures and pressures as Type 1.



TYPE 8-B

Heavy duty, high pressures. Packaged construction for easy installation. Handles pressures to 1200 psi., temperatures from −40°F. to +250°F. Services same as Type 1.



TYPE 9

Famous as a problem solver. Sealing members of chemically inert Du Pont Teflon. Engineered to service conditions to handle practically all destructive acids, corrosives and gases at temperatures from −120°F. to +500°F., pressures to 150 psi. Available in balanced construction for pressures to 750 psi.

This is part of an actual memo sent by one plant manager to others of the same company in different sections of the country—and that company is now exclusively specifying these and other type "John Crane" Shaft Seals for *all* their liquid handling requirements.

You too can save time, trouble and expense by doing likewise.

You'll find a "John Crane" Shaft Seal for every service . . . from hot or cold water to the most destructive acids and corrosives . . . high temperatures, high pressures . . . in types and sizes to meet practically any mechanical or dimensional requirement.

Send us details on your application. We'll recommend the proper shaft seal. Request Bulletin S-204-3 for complete overall information.

Crane Packing Co., 6430 Oakton St., Morton Grove, Illinois, (Chicago Suburb).

In Canada: Crane Packing Company, Ltd., Hamilton, Ont.

John Crane

MECHANICAL PACKINGS

SHAFT SEALS

TEFLON PRODUCTS

LAPPING MACHINES

THREAD CO

CRANE PACKING COMPANY

Free literature

Begins on page 171

Electric Div, H K Porter Co, Inc, 2437 Fulton St, Chicago 12, Ill.

13 **Micro-miniature** connectors are described in 4-p illustrated brochure MM22. Includes specs, diagrams, general info. Electronic Sales Div, DeJur-Amsco Corp, 45-01 Northern Blvd, Long Island City 1, N. Y.

14 **Rotary solenoids** are topic of 12-p data sheet 1057-S. Covers 156 stock models, includes current-torque charts, line drawings. G H Leland, Inc, 123 Webster St, Dayton 2, Ohio.

HEAT EXCHANGERS, CONDENSERS

15 **Type BCF exchangers** are described and illustrated in 8-p bulletin 1.1K6. Spec sheets give details of 46 sizes. Ross Heat Exchanger Div of American-Standard, Buffalo 5, N. Y.

16 **Condensers,** low-level eductor and multi-jet, are discussed in 8-p illustrated bulletin 5AB. Units are for condensing steam under vacuum at ground level. Includes application, construction, operation info. Schutte and Koerting Co, Dept JA-10, Cornwells Hgts, Bucks County, Pa.

17 **Heat-transfer systems,** high-temperature type, are subject of 12-p bulletin 200. Includes photos, graphs, tables. American Hydrotherm Corp, 10-55 Jackson Ave, Long Island City 1, New York.

MECHANICAL TRANSMISSION

18 **Worm-gear** speed reducers are discussed in 40-p booklet J13. Describes units from .1 to 121 hp. Contains drawings, spec tables showing designs and ratings. Hewitt-Robbins, Inc, 666 Glenbrook Rd, Stamford, Conn.

19 **Power transmission,** conveying, elevating products are discussed in catalog 610. Contains descriptions, specs, application and selection data. Chain Belt Co, Milwaukee 1, Wis.

20 **Flexible couplings** for 150 service applications are subject of 8-p bulletin 10100. Has drawings, cutaway photos, tables. T B Wood's Sons Co, Chambersburg, Pa.

21 **Plastic gasket** and shim stock with double-identification feature is described in 4-p bulletin 570. Chicago-Wilcox Mfg Co, 7701 S Avalon Ave, Chicago 19, Ill.

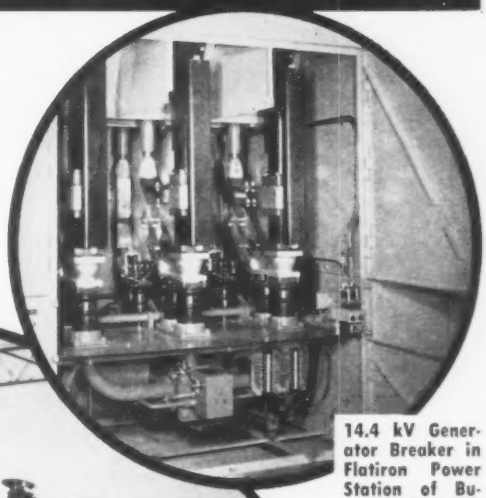
METALS AND ALLOYS

22 **Electrochemicals** are described in 16-p booklet 2152. Lists technical data for 23 products of high-temperature electric furnace. Norton Co, Worcester 6, Mass.

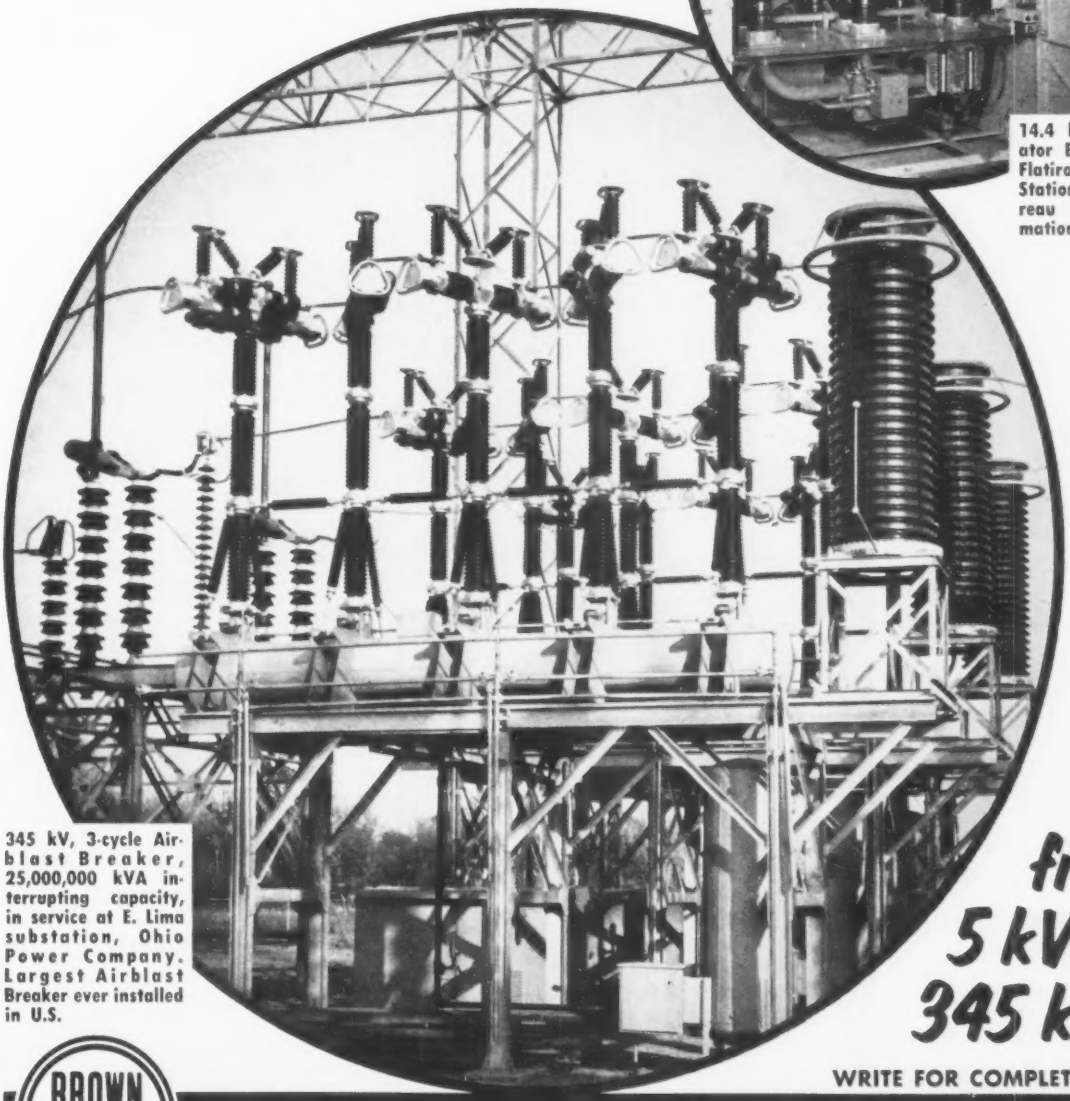
(*Continued on page* 216)

BROWN BOVERI AIRBLAST BREAKERS

ALL SIZES and RATINGS



14.4 kV Generator Breaker in Flatiron Power Station of Bureau of Reclamation.



345 kV, 3-cycle Airblast Breaker, 25,000,000 kVA interrupting capacity, in service at E. Lima substation, Ohio Power Company. Largest Airblast Breaker ever installed in U.S.

from 5 kV to 345 kV!

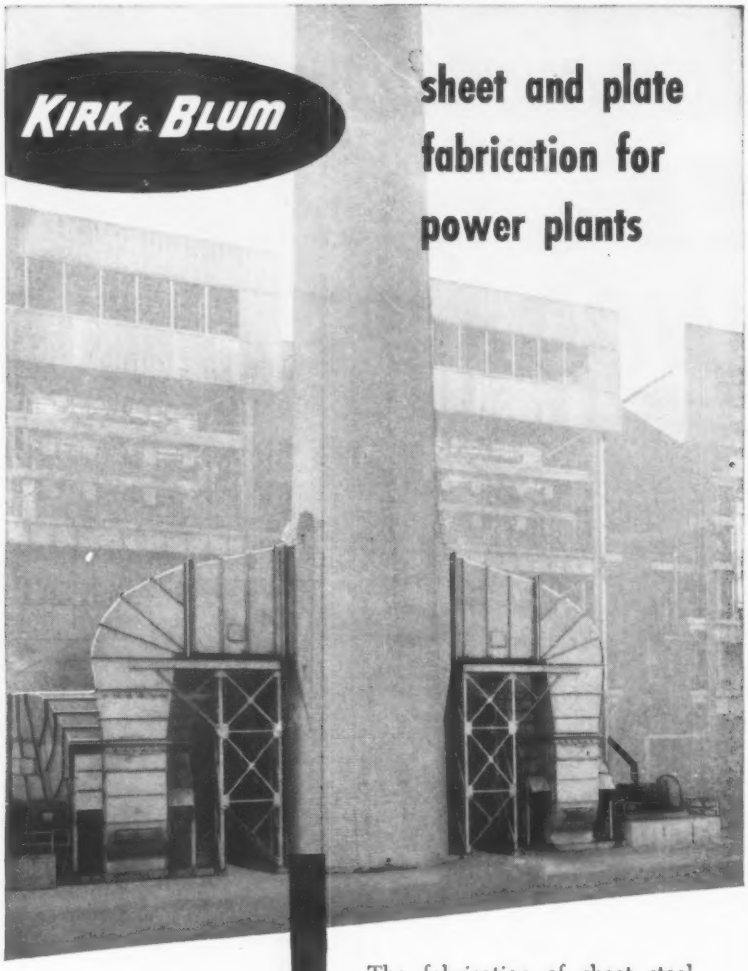
WRITE FOR COMPLETE DATA

BROWN BOVERI

BROWN BOVERI CORPORATION

19 Rector Street • New York 6, N. Y.

Atlanta, Ga. • Birmingham, Ala. • Boston, Mass. • Buffalo, N. Y. • Chicago, Ill. • Cleveland, O. • Dallas, Tex. • Denver, Colo. • Detroit, Mich. Hamilton, O. • Jacksonville, Fla. • Kansas City, Mo. • Knoxville, Tenn. • Miami, Fla. • Minneapolis, Minn. • New Orleans, La. • New York, N. Y. Pasadena, Cal. • Pittsburgh, Pa. • Portland, Ore. • Roanoke, Va. • San Francisco, Cal. • San Juan, P. R. • Syracuse, N. Y. • Tucson, Ariz.



- breechings
- stacks
- air & gas ducts
- casings
- louvers
- bins & hoppers
- insulation jacketing
- control panels & desks

The fabrication of sheet steel and plate to exacting specifications has been a specialty of Kirk & Blum for 50 years. Exceptional experience and complete facilities for fabricating carbon steel, stainless, aluminum, monel and other alloys up to ½" thickness.

Send prints for prompt quotation or write for your copy of the latest Kirk & Blum Sheet and Plate Fabrication Booklet.

Whatever your requirements in sheet and plate fabrication . . . call on KIRK & BLUM.

THE KIRK & BLUM MFG. CO.
3233 Forrer Street, Cincinnati 9, Ohio

Free literature

Begins on page 171

23 **Forging facilities** of new open-die plant are described in 8-p 4-color bulletin. Also lists testing procedures. Alco Products, Inc, Box 1065, Schenectady, N. Y.

24 **Aluminum sheet,** foil availabilities are subject of folder. Includes reference table giving alloys, widths and gages. Kaiser Aluminum & Chemical Sales, Inc, Dept NR-2, 919 N Michigan Ave, Chicago 11, Ill.

25 **Ceramic-coated** metals use in small plants is discussed in 4-p brochure 56. Covers properties, uses. Small Business Administration, Washington, D.C.

26 **Silicone** catalog 1-113 describes 150 commercially available products. Contains charts, tables, graphs, property and performance data and illustrated examples. Dow Corning Corp, Midland, Mich.

METERS AND INSTRUMENTS

27 **Supervisory control** is described in 16-p bulletin GEA-6603. Discusses functions, applications. General Electric Co, Schenectady 5, N. Y.

28 **Mill regulator** for continuous-process industries is subject of 6-p folder K-2503. Photos, drawings detail features. Reliance Electric & Engineering Co, 24701 Euclid Ave, Cleveland 17, Ohio.

29 **Weatherproof** meter houses are described in 12-p catalog. Contains photos, diagrams, installation details for standard, multi-door, walk-in units. Moran Furnace and Sheet Metal Co, 807 E 5th Place, Tulsa, Okla.

30 **Repeat-cycle timers,** sub-miniature hermetically sealed type, are topic of 2-p bulletin AWH RC-301. Contains specs, diagram and photo. A W Haydon Co, Waterbury, Conn.

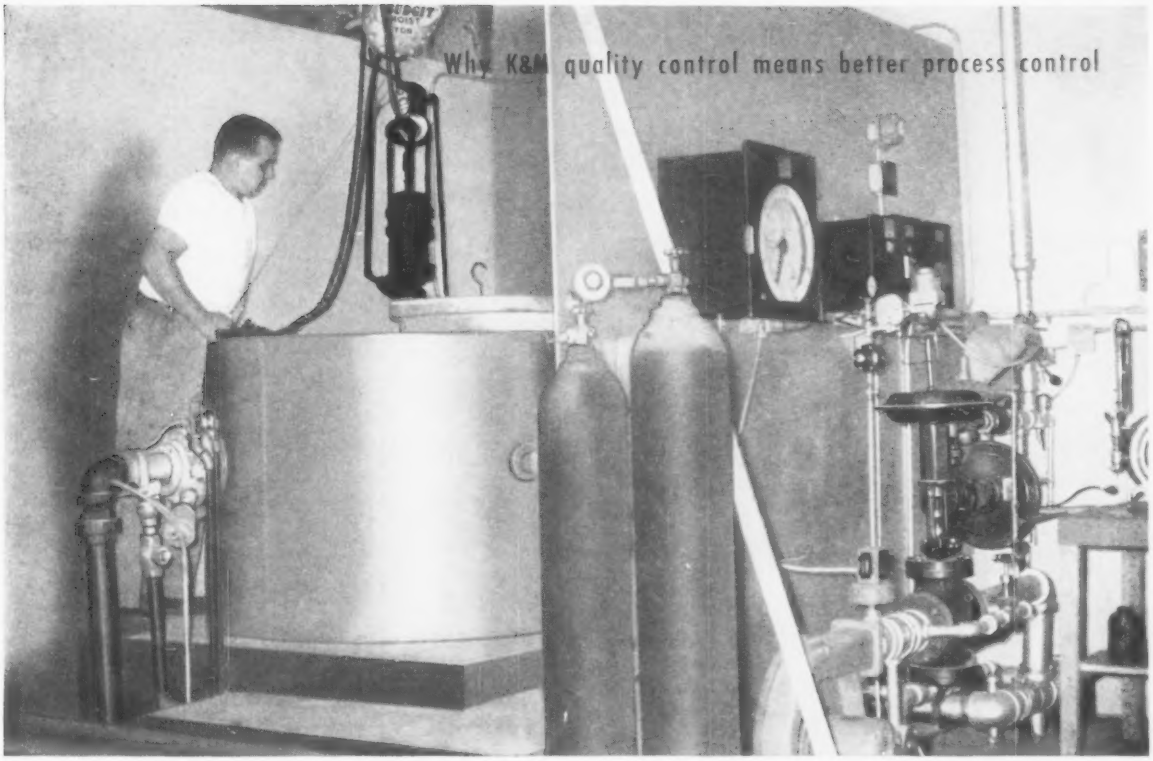
31 **Thermal wells** for thermostat applications in fluids, gases or h-p environments are subject of 2-p catalog. Gives complete specs. Fenwal Inc, Pleasant St, Ashland, Mass.

NUCLEAR ENERGY

32 **Instrumentation,** control of nuclear plants is explained in 8-p booklet B-7233. Illustrated with photos, schematics. Westinghouse Electric Corp, Box 2099, Pittsburgh 30, Pa.

33 **History** of nuclear energy is outlined in booklet, which also describes steps involved in turning crude uranium into fissionable fuel. Illustrates various reactors. Mallinckrodt Chemical Works, 2nd & Mallinckrodt St, St Louis, Mo.

(*Continued on page* 218)



A BREATH OF HELIUM SNIFFS OUT HIDDEN VALVE FLAWS

. . . at high temperatures

To assure the integrity of valve body castings destined for critical services, K&M's quality control engineers supplement routine inspection procedures with a super-sensitive leak test that reveals even the tiniest imperfections.

The valve under test is evacuated and placed in a controlled atmosphere continuously monitored by a gas analyzer. Helium is then pumped into the sealed casting at high pressure. The slightest leakage of the gas into the monitored atmosphere indicates a defect in the casting, and it is rejected.

A test for tightness of valve seating also employs helium. Here leakage through a blocked-shut valve is measured *while the valve is in a furnace* being heated cherry red . . . in steps to 1600°F.

K&M has devised many such special testing techniques to search out concealed flaws so that costly, sometimes dangerous, in-service failures can be eliminated.

Development of new and better quality control methods is a continuing effort at K&M which proves out in your plant.

diaphragm control valves

K&M

Our 78th Year

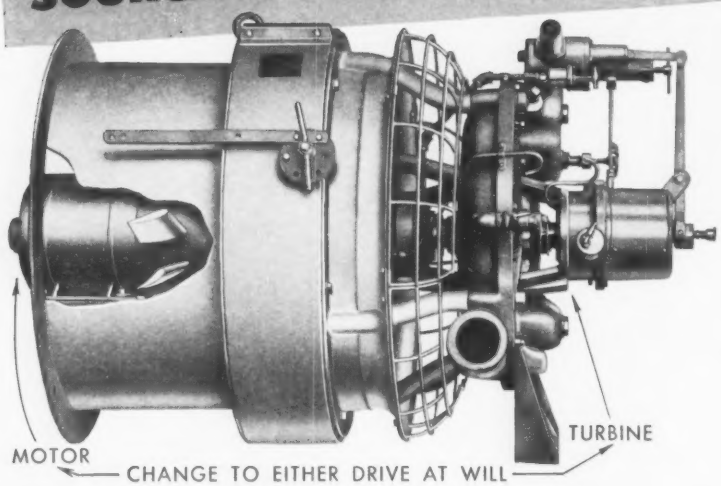
KIELEY & MUELLER, INCORPORATED

Oldest Pressure and Level Control Valve Manufacturer

64 Genung Street, Middletown, New York

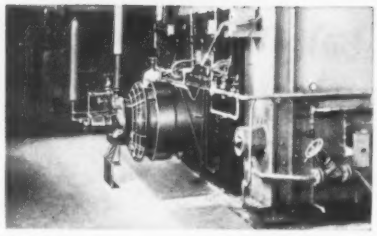
#1599

THE MOST FLEXIBLE SOURCE OF FORCED DRAFT



Wing DUAL DRIVE FORCED DRAFT BLOWERS

Practically two blowers in one. When Turbine Drive is used, its oil-free exhaust can supply process or space heating steam. During electrical emergencies turbine drive insures continued operation. Motor drive may be used for starting-up and when process or heating steam demand is low. Precise draft control, manually or automatically. Completely assembled, ready to install.



Wing Dual Drive Forced Draft Blower at Easton, Pa. plant of the Dixie Cup Co.

Write for a copy of Bulletin FD-5

L. J. Wing Mfg. Co. 50 Vreeland Mills Road · Linden · N. J.
DIVISION OF AERO SUPPLY MFG. CO. INC.

Wing
DUAL DRIVE
BLOWERS

FANS • UNIT HEATERS • DRAFT INDUCERS • BLOWERS • TURBINES

Free literature

Begins on page 171

34 **Facilities** for melting, fabricating, testing available in nuclear and specialty-metals plant are discussed in 5-p bulletin. New plant is designed primarily for manufacture of atomic-fuel elements and components. D E Makepeace Co, Pine & Dunham Sts, Attleboro, Mass.

VALVES

35 **Steam regulating** valves with pilots for fast- and slow-heating exchangers are subject of 6-p bulletin 1012. Includes selection tables, line drawings. Spence Engineering Co, Inc, Walden, N. Y.

36 **Refrigeration,** air-conditioning valves, accessories and fittings are discussed in 20-p catalog. Includes illustrations, technical data on ASME-approved relief valves. Superior Valve & Fittings Co, 1509 W Liberty Ave, Pittsburgh 26, Pa.

37 **Solenoid** valves, models 271, 272, 273 and 274, are subject of four 2-p bulletins. Units are for liquid and suction-line refrigerant application. Controls Co of America, 2450 N 32nd St, Milwaukee 45, Wis.

38 **Sliding - gate** temperature - control valves are topic of 6-p bulletin J-180. Describes features and method of operation, contains sizing charts, dimensional drawings, specs. Jordan Industrial Sales Div of OPW Corp, 6013 Wiehe Rd, Cincinnati 13, Ohio.

39 **Steam traps** for industrial process are described in bulletin HPT-1. Includes cast-bronze and semi-steel units. Barnes & Jones, Inc, Box 207, 34 Crafts St, Newtonville 60, Mass.

40 **Duplex transfer valves** are listed in new bulletin. Contains design, performance info. A W Cash Co, Box 551, Decatur, Ill.

"Don't forget to log what?"

Ankorite

TRIPLE "U" BRAND LEATHER PACKING

...Better Performance for Accumulators and Hydraulic Presses!

Ankorite Triple "U" Brand Leather Packing is an excellent flexible packing ring for oil and hydraulic press plungers, accumulators, Triplex pump plungers and hydraulic rams. Due to their construction, two rings of Triple "U" packings are used in replacing ordinary molded U leather or cup leathers.

Ankorite Triple "U" is immediately available in coil form in multiples of 10 feet or in continuous lengths up to 400 feet, and in sizes ½" to 1¼" in packing width.

Write us your needs today.

DISTRICT OFFICES

BALTIMORE, MD.	CLEVELAND, OHIO	LOS ANGELES, CAL.	PHILADELPHIA, PA.
BOSTON, MASS.	DAYTON, OHIO	MILWAUKEE, WIS.	PITTSBURGH, PA.
BUFFALO, N.Y.	DETROIT, MICH.	MONTREAL, CANADA	SAN FRANCISCO, CAL.
CINCINNATI, OHIO	HOUSTON, TEX.	NEW ORLEANS, LA.	SEATTLE, WASH.
CHICAGO, ILL.	INDIANAPOLIS, IND.	NEW YORK, N.Y.	SPOKANE, WASH.
ST. LOUIS, MO.	TOLEDO, OHIO	WILMINGTON, CAL.	

THE ANCHOR PACKING COMPANY

GENERAL OFFICES: PHILADELPHIA, PA.

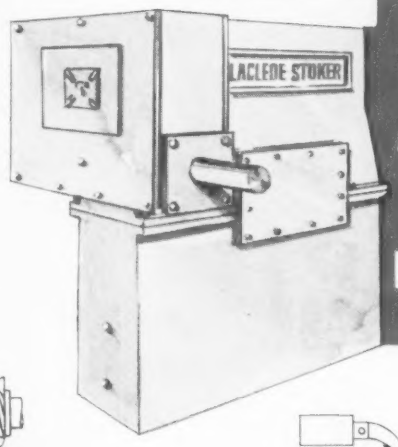
FACTORIES: MANHEIM, PA. ELKHART, IND. MONTREAL, CAN.

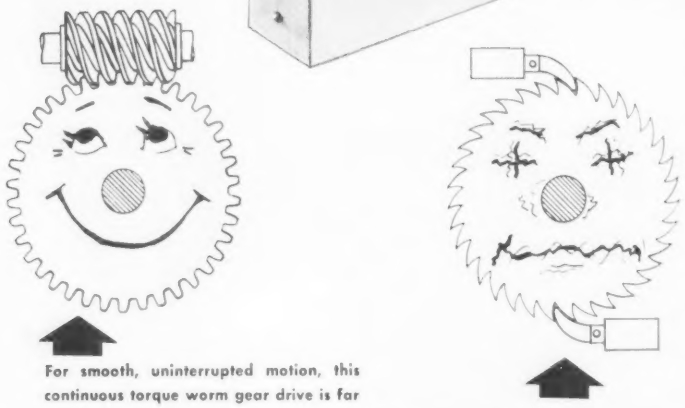
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

Announcing
LACLEDE'S
NEW MODERN
WORM GEAR DRIVE

AVAILABLE NOW!

YEARS AHEAD IN DESIGN





For smooth, uninterrupted motion, this continuous torque worm gear drive is far superior . . . . . to any intermittent ratchet drive.

These new worm gear drives on all Laclede Chain Grate Stokers have oversize insert-type sleeve bearings on both worm shafts and a heavy duty roller thrust bearing on the slow speed worm shaft. They can be hydraulically, electrically or steam operated.

Attractively housed, these dependable, new drives provide smooth, quiet, trouble-free operation, resulting in lower tooth pressures, no shock loading, no intermittent stressing, less wear on other stoker parts, and overall longer stoker life.

You can expect, and you get, low operating and maintenance costs with Laclede Chain Grate Stokers. Low initial cost, too. Investigate before you buy.

FOUNDED IN 1904

LACLEDE STOKER COMPANY
4440 HUNT AVE. • ST. LOUIS 10, MO.

My biggest boner

A large wood-working plant had lots of exhaust steam from powerhouse steam engines to waste. To remedy problem, piping was placed in a long covered bridge used as a passageway for finished products. Exhaust from engines was to be used to heat warehouse. Job required a supply pipe, about 300-ft long, with expansion joints.

Boss found two good places to anchor the ends of his pipe. Slip-type expansion joint was installed fully extended in the line. All figures showed that the expansion joint could take care of all expansion. But the boss slipped up on one detail. He knew his boss was a nontechnical crank with no practical trade training. He remembered that nice finished goods and a new hardwood floor were subject to some damage if that expansion joint dripped water.

To avoid a run-in with his cranky boss, he pulled up the packing gland himself, making sure it was tight so it wouldn't leak. Then he turned on the steam. Presently a loud crash came from the piping-end anchored to the concrete wall. The wall was badly shattered but the expansion joint had not moved at all. Reason was that the packing had been pulled up too tight. Thereafter the boss saw to it that joints of this nature were left with packing loose, until the steam had been turned on.

H B McDermid, *Long Beach, Calif.*

Reports from the field

Begins on page 158

various combinations to meet a wide variety of "special" requirements were designed for volume production. At the same time, facilities were organized for assembly-line economy. New materials-handling equipment installed was almost all automatic. Same three points were kept in mind in automating production of a variety of standard motors.

A teletype communications system insures motor standardization. Punched-tape model lists send information for manufacture and sched-

POWELL

world's largest family of valves

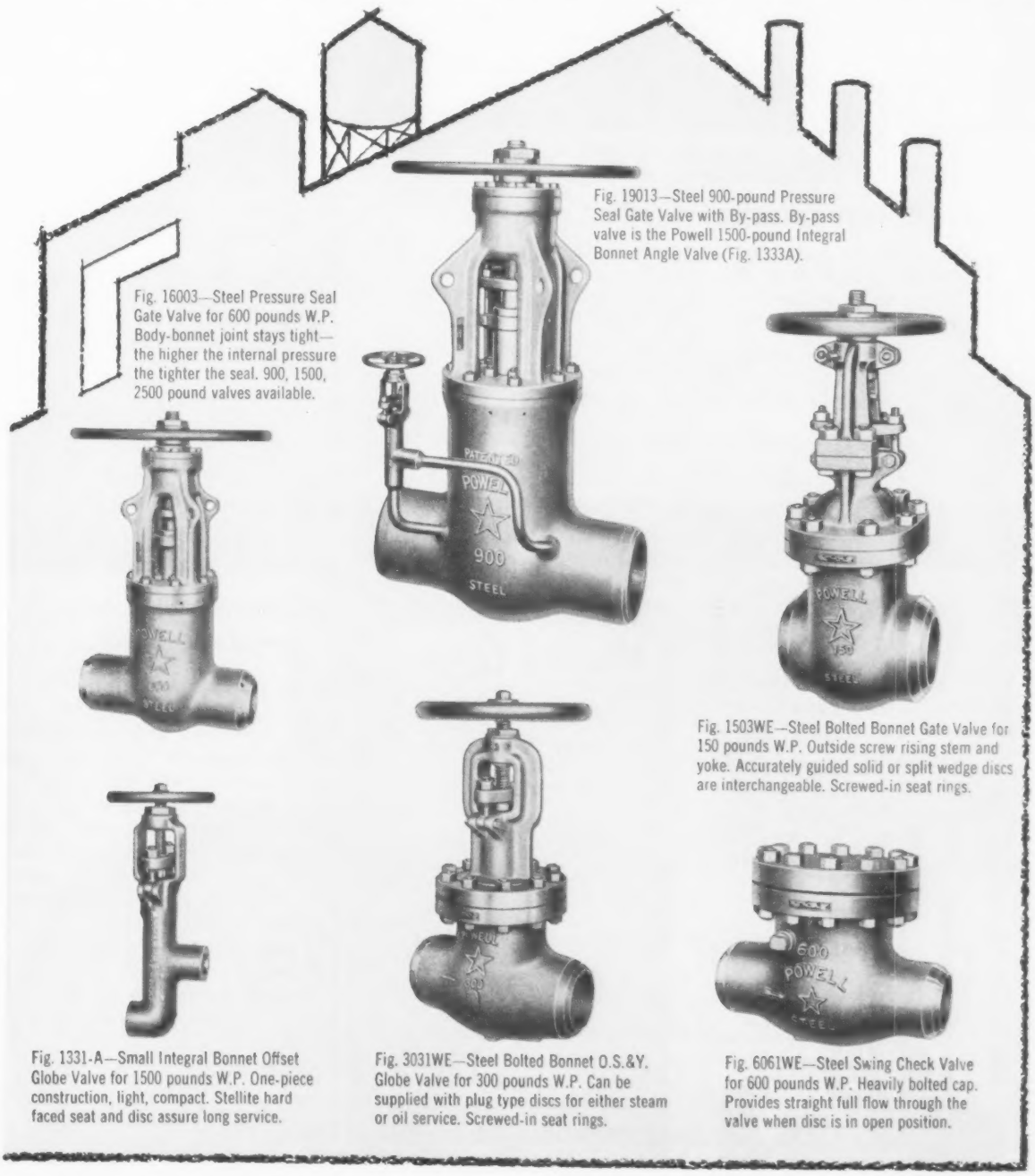


Fig. 16003—Steel Pressure Seal Gate Valve for 600 pounds W.P. Body-bonnet joint stays tight—the higher the internal pressure the tighter the seal. 900, 1500, 2500 pound valves available.

Fig. 19013—Steel 900-pound Pressure Seal Gate Valve with By-pass. By-pass valve is the Powell 1500-pound Integral Bonnet Angle Valve (Fig. 1333A).

Fig. 1503WE—Steel Bolted Bonnet Gate Valve for 150 pounds W.P. Outside screw rising stem and yoke. Accurately guided solid or split wedge discs are interchangeable. Screwed-in seat rings.

Fig. 1331-A—Small Integral Bonnet Offset Globe Valve for 1500 pounds W.P. One-piece construction, light, compact. Stellite hard faced seat and disc assure long service.

Fig. 3031WE—Steel Bolted Bonnet O.S.&Y. Globe Valve for 300 pounds W.P. Can be supplied with plug type discs for either steam or oil service. Screwed-in seat rings.

Fig. 6061WE—Steel Swing Check Valve for 600 pounds W.P. Heavily bolted cap. Provides straight full flow through the valve when disc is in open position.

For every flow control problem Powell offers more kinds or types, available in the largest variety of metals and alloys to handle every flow control requirement. Powell distributors are located in all principal cities and maintain inventories to fill almost any need. For special engineering problems, write direct to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

with the ALLPAX
Extension Gasket Cutter

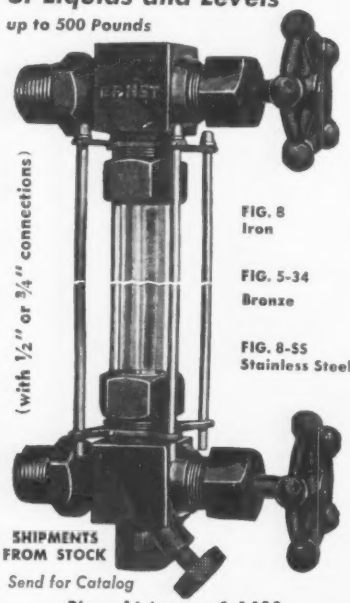
There is no gasket too large to be cut with the Allpax Extension Gasket Cutter. With the simple addition of extra 6" extension arms, the radius can be increased as required. Without extensions this handy, versatile tool cuts diameters from ¼" to 12".

Make replacement gaskets quickly and easily with the Allpax Extension Gasket Cutter and avoid costly delays in operation.

SEND FOR OUR NEW CATALOG TODAY!
See our complete line of packings, tools, and gasket materials. Contact our distributor or write to: Dept. C

THE ALLPAX COMPANY
160 Jefferson Ave. • Mamaroneck, N. Y.

ERNST
Gages for the Observation of Liquids and Levels
up to 500 Pounds



Send for Catalog
Phone Livingston 6-1400
ERNST WATER COLUMN & GAGE CO.
LIVINGSTON, NEW JERSEY
Manufacturers for More Than 50 Years

NELSON COMPANY

STEAM FITTERS —
PIPING CONTRACTORS
ERECTORS & FABRICATORS
OF
CARBON — STAINLESS —
ALLOY — PLASTIC &
PVC MATERIALS

STEAM
PULP & PAPER MILLS
STEEL MILLS
GAS & WATER UTILITIES
CHEMICAL PROCESS SYSTEMS
REFINERIES
SEWAGE SYSTEMS

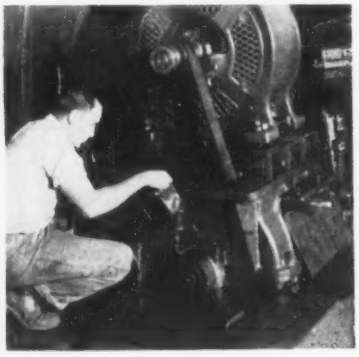
NELSON COMPANY
AMOSLAND RD. AT B. & O. R.R.
HOLMES, PENNA.
LEHIGH 2-7900

Reports from the field

Begins on page 158

uling to different parts of factory. Use of tape keeps paperwork down, speeds up production cycle, provides production and inventory control.

Motors are manufactured in two buildings. A component-parts building produces parts on basis of an estimate of future orders. Assembly area works from customers' orders, using stock of component parts to shorten delivery time. Materials-handling features include a conveyor installation to carry parts between buildings through a covered bridge.



Rubber-fabric belt drive operates at a whisper

Replacement of a gear drive with a rubber-fabric transmission belt with teeth has eased noise and lubrication headaches for a mill that bores giant stainless-steel ship propellers. Belt for the 144-in. mill is 120-in. in circumference, 4-in. wide. It is strengthened with steel wire, has teeth and turns in a grooved pulley to give silent, non-slip power transmission.

Timing belt made by United States Rubber Co needs no lubrication; worker in picture is oiling the 30-hp motor to which belt is attached.

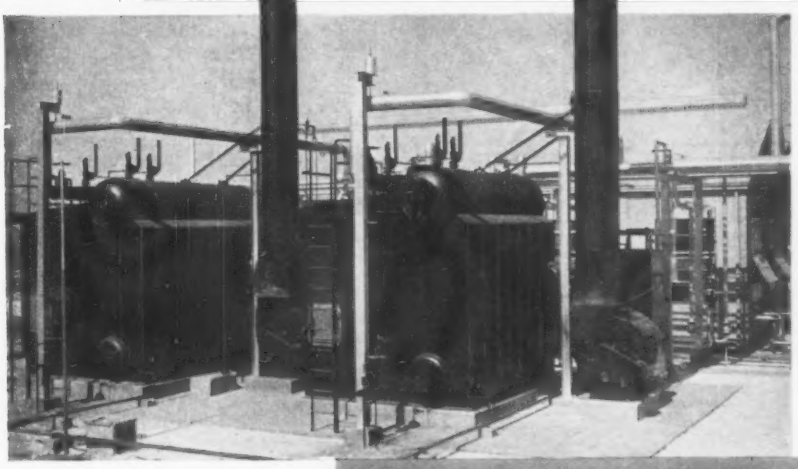
Calendar of Events

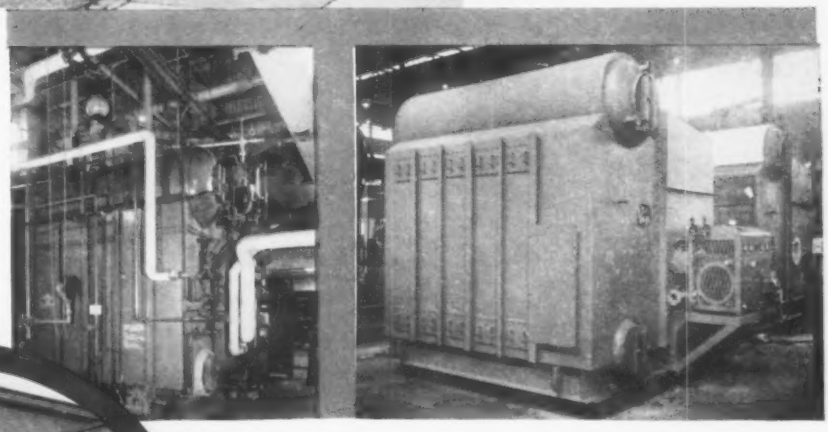
March 17-21—National Assn of Corrosion Engineers, 14th Annual Conference. Civic Auditorium, San Francisco, Calif. Details from NACE, 1061 M & M Bldg, Houston 2, Texas.

March 17-21 — International Atomic Exposition, Inc, in con-

Vogt

Package STEAM BOILERS *give* versatility with economy

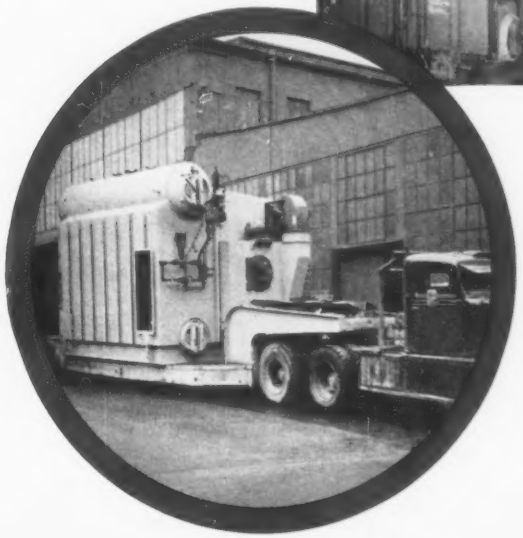




Above: Two units serve a gas pipeline company.

Left: Installation in fibre box-board plant.

Right: Unit for a leading soap manufacturer.



Enroute to an office building.

FOR POWER, PROCESS OR HEATING

Available in capacities from 10,000 to 50,000 pounds steam per hour in three standard pressures of 175, 250 and 375 pounds per square inch gage, factory assembled.

Write for Bulletin PSG-2, Dept. 24A-BP

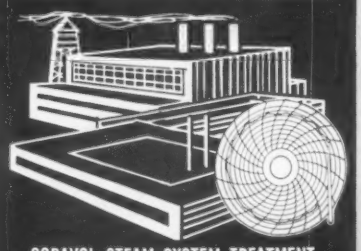
HENRY VOGT MACHINE COMPANY, Louisville, Ky.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati.

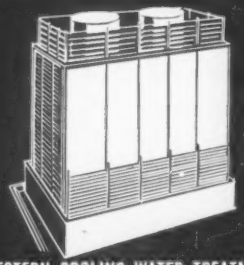
OTHER VOGT PRODUCTS:

DROP FORGED STEEL VALVES, FITTINGS, FLANGES AND UNIONS
PETROLEUM REFINERY AND CHEMICAL PLANT EQUIPMENT
HEAT EXCHANGERS • ICE MAKING & REFRIGERATING EQUIPMENT

WESTERN BOILER FEED WATER TREATMENT



CORAVOL STEAM SYSTEM TREATMENT



WESTERN COOLING WATER TREATMENT and ALGAECIDE

ANTI-FOAMS for BOILER WATER
WESTO POTABLE WATER TREATMENT
WESTERN SWEET WATER TREATMENT
WESTO BRINE TREATMENT
WESTERN FUEL OIL SLUDGE DISPERSANT
WESTERN SOOT REMOVER
WESTERN LIGHTNING SCALE REMOVERS
WESTERN ALUMINA No. 45 COAGULANT

SOLVE your PROBLEMS of

WATER STEAM and FUEL TREATMENT

Economically! Dependably! with

WESTERN CHEMICAL

To preserve your equipment and to keep it operating continuously, efficiently, and economically, is the purpose and end result of the use of specialized Western formulas and the individual technical service that goes with them.

Whether your problem is scale or pitting in your boilers—corrosion in your steam and condensate lines—scale, corrosion or algae growth in your cooling water system—sludge in your fuel oil supply—soot in combustion areas—or any other problem related to your use of water, steam or fuel—it can be solved by Western Chemical Company. That is our business and it has been for over 65 years.

From this one source you can get the benefit of long experience, combined with the most advanced technical methods, to save you the cost of repairs, replacements, and service interruptions.

RELY ON WESTERN.

ONE Source for Complete Technical Information

In the series of Western Technical Bulletins you will find the story behind your particular problem—its causes and prevention. Without obligation, take advantage of this opportunity which can lead to definite savings in both costs and headaches. Write today for complete information.

Send **TODAY** for **FREE** Literature

WESTERN CHEMICAL CO., 713 Washington St., Kansas City 5, Mo.
I am particularly interested in the chemical treatment of:

_____

Please send me complete information.

NAME _____

FIRM _____

ADDRESS _____

CITY _____ ZONE ___ STATE _____

Reports from the field

Begins on page 158

junction with **1958 Nuclear Congress,** Atomfair of the Atomic Industrial Forum. International Amphitheatre, Chicago, Ill. Details from Gray & Rogers, 12 S 12th St, Philadelphia 7, Pa.

March 19-20—American Society of Mechanical Engineers in conjunction with **American Institute of Electrical Engineers,** Engineering Management Conference. Hotel Somerset, Boston, Mass. Details: ASME, 29 W 39th St, New York 18, N. Y.

March 26-28—Illinois Institute of Technology, 20th Anniversary Meeting of American Power Conference. Hotel Sherman, Chicago. Details: R A Budenholzer, mechanical engineering dept, IIT, 3300 Federal St, Chicago 16, Ill.

March 27-29—Electrical Maintenance Conference. Shrine Exposition Hall, Los Angeles. Details from F J Tabery, 3443 S Hill St, Los Angeles 7, Calif.

March 31-April 2—American Institute of Electrical Engineers, Southwest District Meeting. Mayo Hotel, Tulsa, Okla. Details from AIEE, 29 W 39th St, New York 18, N. Y.

April 14-15—American Society of Mechanical Engineers, Maintenance and Plant Engineering Conference. Penn-Sheraton Hotel, Pittsburgh, Pa. Details from ASME, 29 W 39th St, New York 18, N. Y.

April 14-17—American Society of Mechanical Engineers, Design Engineering Conference. International Amphitheatre, Chicago, Ill. Details: ASME, 29 W 39th St, New York 18, N. Y.

April 15-17—American Welding Society, Annual Welding Show. Kiel Auditorium, St Louis, Mo. Details from AWS Welding Show, c/o R T Kenworthy, 12 E 41 St, New York 17, N. Y.

April 24-25—American Society of Mechanical Engineers, Management Conference. Hotel Statler,

(*Continued on page 228*)

NOW – 30% More Coverage and a finish WHITER than ever

. . . with BALDWIN-HILL IMPROVED SUPER POWERHOUSE® CEMENT

Baldwin-Hill research has developed an IMPROVED Super Powerhouse single-coat, insulating-finishing Cement which provides greatly increased dry coverage — 144 sq. ft., 1/4 in. thick or 72 sq. ft., 1/2 in. thick, per 100 lbs. In addition to greater coverage, shrinkage on drying is negligible, insuring tight joints and freedom from cracks.

The new Improved Super Powerhouse trowels to a high glaze in a bright white finish. And rain, sleet or snow does not adversely affect the cement after setting.

See the B-H catalog in Sweet's Plant Engineering File.

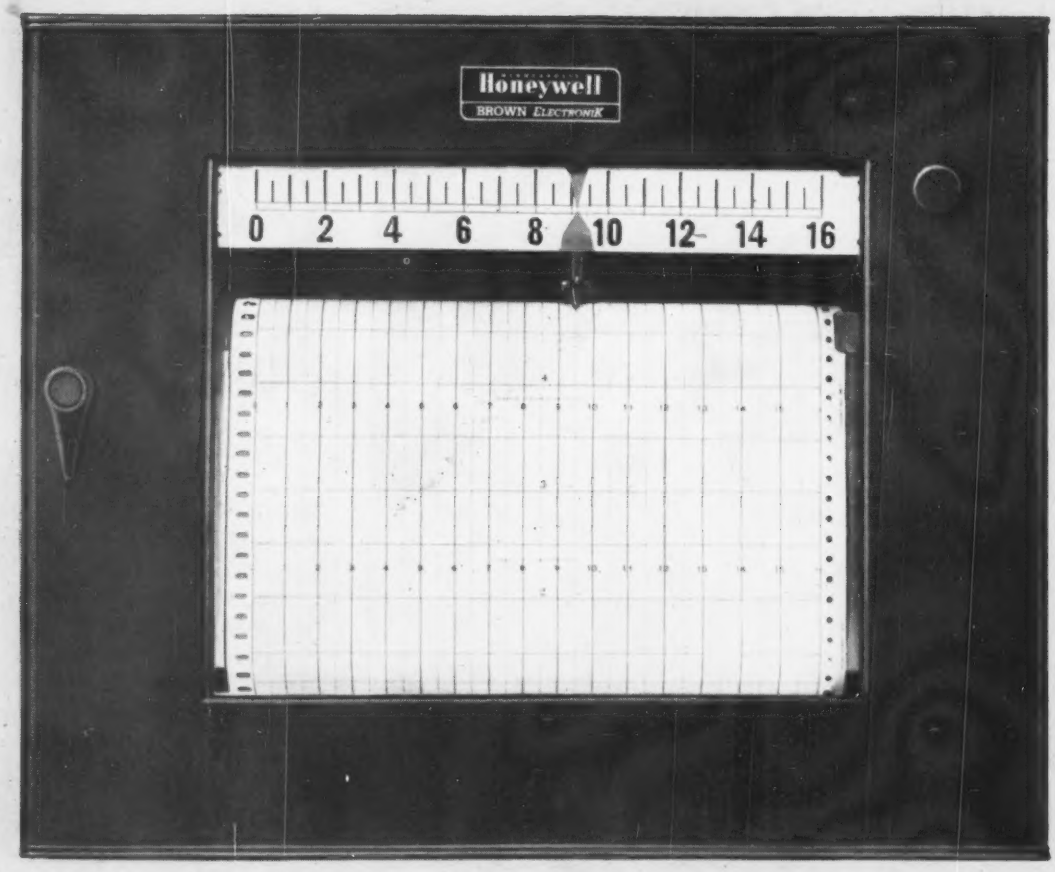
BALDWIN-HILL COMPANY

Complete line of Industrial Insulations

103 Breunig Avenue • Trenton 2, N. J.

Kalamazoo, Mich. • Huntington, Ind. • Temple, Texas

Write for new 1958 brochure on B-H Improved Super Powerhouse Cement and its companion product, B-H Mono-Block.®



ElectroniK **STRIP CHART CONTROLLER for applications where highly detailed records, long-term charts, high accuracy of control setting are required.**

ElectroniK **CIRCULAR SCALE CONTROLLER for applications where a record is not needed and where readability at extreme distances and precision reading closeup are desired.**

ElectroniK **CIRCULAR CHART CONTROLLER for applications where high accuracy of scale reading is required. Large 28⅝-inch scale is easily read at distance to 60 feet. Charts are 12 inches in diameter, convenient for daily filing.**

Improve Boiler Efficiency

with *ElectroniK* instruments for pH and conductivity control

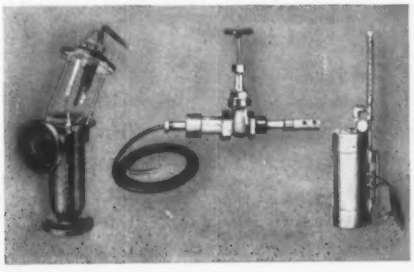
Accurate pH and conductivity control can help give you best possible boiler performance—and more. It can extend the life of your steam generating equipment, from the boiler itself to the smallest heat exchanger . . . and keep maintenance to a minimum.

There are many reasons why *ElectroniK* instruments give superior control of pH and conductivity. They're sensitive enough to respond to a change as small as 3 parts in 10,000. They're calibrated within limits as small as ±0.2% of scale span. "Building block" design uses sturdy, self-enclosed components . . . reduces inspection and service requirements to a minimum.

Use *ElectroniK* pH and conductivity instruments to advantage in boiler water preparation . . . in checking water salinity and steam condensate . . . in condenser leakage control. Your nearby Honeywell field engineer can give you complete details. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

pH and CONDUCTIVITY CELLS, available in many types, are accurate over a wide range, easy to maintain, stable, and ruggedly constructed.



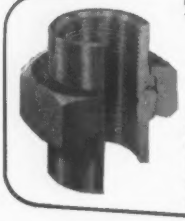
Honeywell

First in Controls

Catawissa PERFECT SEAL Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!



Standard & Double Extra Heavy UNIONS

Available with screwed or socket weld ends. 3000-lb. sizes ⅛" to 3"; 6000-lb. sizes ⅛" to 2".

ORIFICE UNIONS

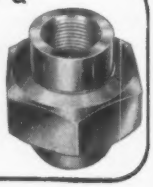
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS

With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS

With screwed or socket weld ends. 3000-lb. and 8000-lb. service.



WRITE FOR CATALOG 56
showing the complete Catawissa line of Perfect Seal Products

CATAWISSA VALVE AND FITTINGS COMPANY
206 Mill St. • CATAWISSA, PA.

Reports from the field

Begins on page 158

New York. Details from ASME, 29 W 39th St, New York 18, N. Y.

May 1-8—American Society of Tool Engineers, Tool Show and 26th Annual Convention. Philadelphia Convention Center, Philadelphia, Pa. Details from ASTE, 10700 Puritan Ave, Detroit 38, Mich.

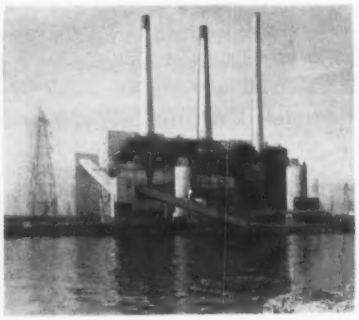
May 4-7—Air-Conditioning and Refrigeration Institute, Board and Annual Meeting. The Homestead, Hot Springs, Va.

May 7-11, 1958—Western Air Conditioning Industries Assn, Conference and Exhibit. Shrine Exposition Hall, Los Angeles. Details: F J Tabery, 3443 S Hill St, Los Angeles 7, Calif.

May 12-16—American Society for Metals, Southwestern Metal Congress and Exposition. Automobile Bldg, State Fair Park, Dallas, Texas. Details from ASTM, 7301 Euclid Ave, Cleveland 3, Ohio.

May 14-16—Society for Experimental Stress Analysis, Spring Meeting. Hotel Manger, Cleveland, Ohio. Details from Dr W M Murray, Box 168, Cambridge 39, Mass.

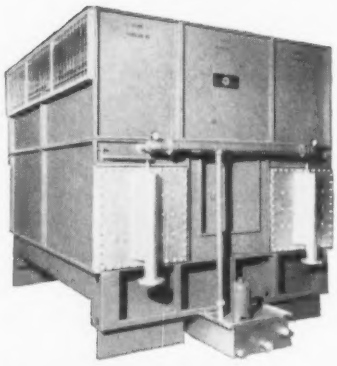
May 26-27—Stanford Research Institute, Western Area Development Conference. Vancouver, B. C. Details from C L Hamman, Economics Research Div, Stanford Research Institute, Menlo Park, Calif.



April start-up scheduled for River Rouge generator

Last steam turbine-generator of a

(*Continued on page* 232)



Is your plant CRITICALLY SHORT of WATER?

You will make major water savings, reduce your costs, solve your problems of water supply or disposal and get HIGH OPERATIONAL EFFICIENCY with Niagara "Aero" Evaporative Heat Exchangers, After Coolers or Condensers for these important plant services or processes:

- AFTER COOLING and air drying for large air and gas compressors and AIR LIQUEFACTION
- COOLING ENGINES, COMPRESSORS, HYDRAULIC PRESSES
- COOLING QUENCH BATHS, FURNACES, INERT ATMOSPHERES
- COOLING ROLLS, WELDERS, DRAWING OR EXTRUSION DIES
- PRODUCT AND PROCESS COOLING CHEMICALS OR INTERMEDIATES
- COOLING LIQUIDS OR GASES IN CLOSED SYSTEMS
- VAPOR CONDENSING UNDER VACUUM
- ELECTRONIC PROCESS COOLING

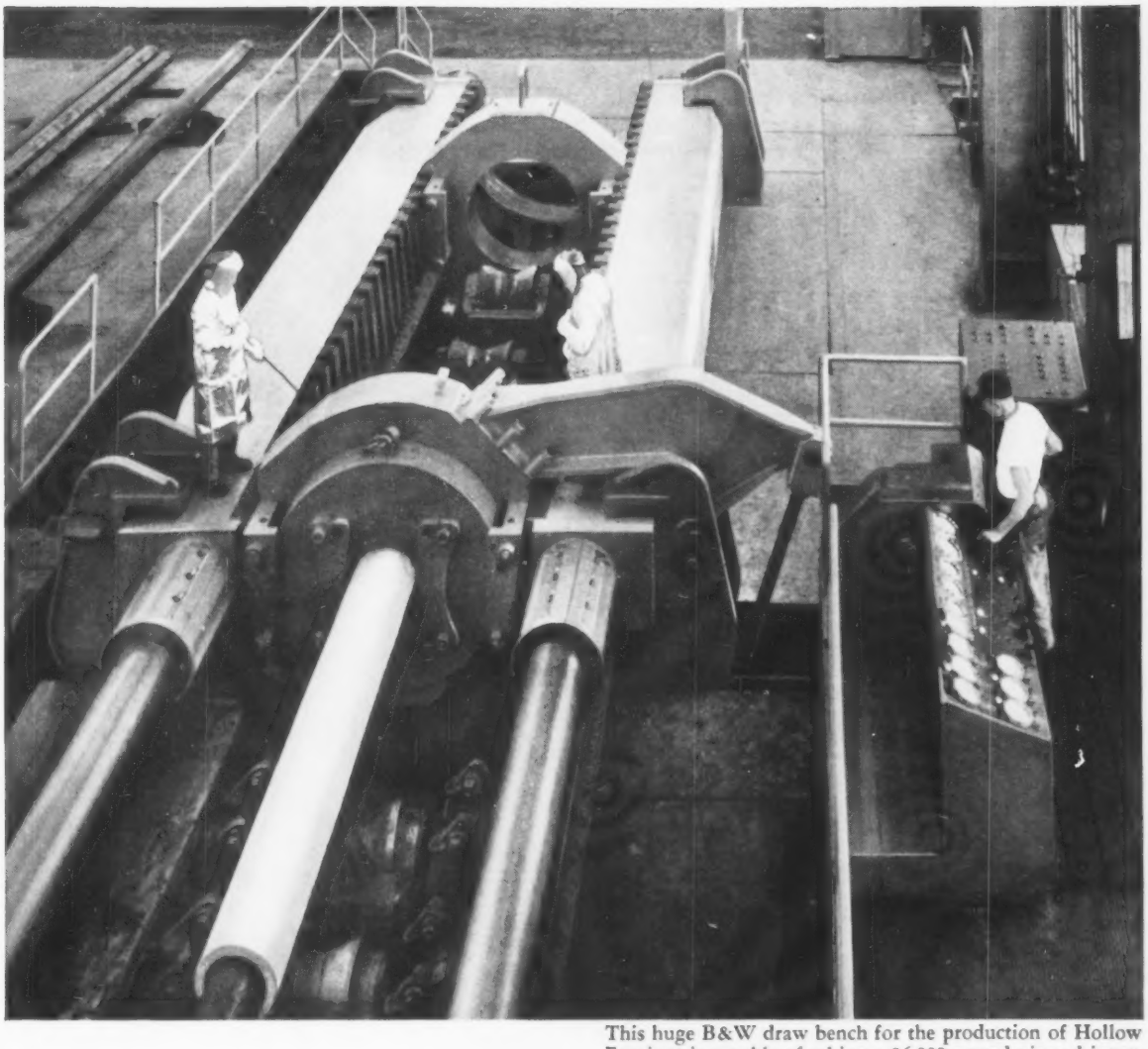
High operational efficiency means: precise temperature for improved product and process quality control, heat removal at rate of input, simple operating conditions, real economy in upkeep, sustained full capacity.

Also it means cooling in a closed system with your product kept free from contamination or, when condensing, getting a pure condensate holding high quality in your product or material.

Niagara machines do the work of a cooling tower plus shell-and-tube coolers with a single machine that saves piping, water handling disposal and treatment expense and 95% of water consumed by contact cooling methods.

Write for Bulletin 129, 130, 132, 136R.

NIAGARA BLOWER COMPANY
Over 35 years of Service in Industrial Air Engineering
Dept. P-3, 405 Lexington Avenue
NEW YORK 17, N. Y.
District Engineers in Principal Cities of U. S. and Canada



This huge B&W draw bench for the production of Hollow Forgings is capable of taking a 26,000 pound pierced ingot.

B&W Hollow Forgings —for piping economy in heavy-duty service

Petroleum and power engineers have found a solution of their piping problems at B&W. They save time and money by specifying high-quality B&W Hollow Forgings that have been produced under carefully controlled conditions from initial electric furnace melting through final inspection. B&W production techniques include uniform and thorough working of the ingot, which result in excellent forging properties.

Piping is being supplied in a wide range of fractional sizes and a selected range of standard pipe sizes in carbon, intermediate Croloy and stainless Croloy steels.

For additional information, write for Bulletin S-16. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio. S-474-HF

Ask for this BULLETIN: S-16

BABCOCK & WILCOX

BOILER DIVISION

HOW TO SELECT WATER-CONDITIONING EQUIPMENT (NO. 7 OF A SERIES)

*Water Impurities and Methods of Treatment**

HARDNESS *(Scale)* Calcium or magnesium salts such as bicarbonates, chlorides and sulfates	**Ion Exchange** (zeolite softeners). Generally used on clean, clear water to reduce hardness to a very low figure. Also avoids repumping. **Precipitator** (cold lime-soda softening). Used where turbidity, color or iron or manganese are also to be removed. Sometimes used for softening only—gives lower operating cost than ion exchange on high-carbonate-hardness waters. Reduces hardness to a few grains per gallon. Can be followed by zeolite softeners. **Hot-process Softener** (lime-and-soda process) usually followed by anthracite filter. Used for boiler feedwater. Also removes silica. Reduces hardness to a few grains per gallon. If followed by a zeolite softener (optional), no soda ash is used.
TURBIDITY Suspended dirt, sand, silt or other solids	**Sand Filter** (gravity or pressure type) alone . . . for water with moderately low turbidity content. **Precipitator** will reduce bulk of turbidity; generally followed by sand or anthracite filter for practically complete removal.
COLOR Dissolved or finely divided organic matter	A **Precipitator** with alum coagulant is generally used. Powdered activated carbon is sometimes added for further reduction of color. **Chlorination** may be used to kill living organic matter.
BAD TASTE OR ODOR Hydrogen sulfide (H_2S), cause of "rotten egg" odor	**Aeration** with several hours detention. **Adding chlorine:** Expensive except for removing small residuals. **Forced-draft degasifier:** Used if there are 10 or more ppm of H_2S or if CO_2 is also to be removed. **Carbon Purifier** (Carbo Dur®) or **Manganese Zeolite Filter:** For small volumes of water with 2 ppm or less H_2S.
Algae, organic matter	Same treatment as for COLOR. A **Carbon Purifier** may be used for small volumes of water . . . preceded by a sand filter if turbidity or debris is to be removed.
Excess chlorine	A **Carbon Purifier** provides simple, automatic operation. Also removes other causes of tastes and odors. **Sodium Sulfite** treatment reduces chlorine at lower equipment cost.
CORROSIVENESS Low pH due to free mineral acids	Neutralize with caustic soda, soda ash or lime.
Low pH due to carbon dioxide (CO_2)	**Aeration** reduces CO_2. A **forced-draft degasifier** removes practically all CO_2. **Neutralizing Amines** are used for corrosive hot condensate. Feeding **sodium silicate** will coat inside of pipes.
Alkalinity (carbonates and bicarbonates that form CO_2 under heat)	Can be reduced in a **Precipitator** with lime. Can also be removed by **Ion Exchange** (2 methods): Cation exchanger, sodium cycle, plus strongly basic anion exchanger, chloride cycle . . . for lower equipment cost on small flow rates, no handling of acids or alkalis, no blending of effluents. Cation exchanger, hydrogen cycle, then neutralization by blending with softened water or addition of caustic soda ("H and Na treatment") . . . for lower equipment cost on high flow rates and reduction of total solids.
IRON OR MANGANESE Ferrous or Manganous compounds (dissolved), bicarbonates, etc.	Up to 50 ppm of Fe can be removed with cation exchanger, sodium cycle—if water is clear and unaerated. **Aeration, raising** pH with lime, **settling** (in catch basin or Precipitator) and **filtering** will remove iron. If raw water pH is high enough to cause iron to precipitate on aerating, the lime or settling or both may be omitted. **Manganese Zeolite** ("oxidizing filter") for water with up to 2 ppm of iron or manganese.
Suspended iron (ferric hydroxide)	**Sand filter**—sometimes with a coagulant such as alum added just ahead of the filter.
SILICA *(Turbine blade scale)*	**Hot process softener** (and anthracite filter) for low and medium pressure boilers. **Ion exchange** (demineralizing) for more complete silica reduction for high pressure boilers.

***Factors in selecting specific treatments include:** initial or operating cost or space limitations, plans for future expansion, characteristics of raw water, desired effluent quality and volume . . . and degree of operating skill available (automatic vs. manual operation, facilities for routine chemical testing, etc.).

THE PERMUTIT COMPANY, Dept. P-3, 50 West 44th St., New York 36, N. Y.

PERMUTIT®
rhymes with "compute it"
a division of PFAUDLER PERMUTIT INC.
Water Conditioning
Ion Exchange • Industrial Waste Treatment

General Electric Announces...

ALL-NEW WEATHER PROTECTED MOTOR

Wind, rain, snow, and even hurricanes, are little hazard to General Electric's ***new*** Weather Protected Motor—first major redesign of weather protected motors since their 1948 introduction.

General Electric's new design offers you the best outdoor protected drive available for your motor needs. Just install it, and don't worry about it when adverse weather strikes.

ALL-WEATHER PROTECTION built in the new design is the result of a unique top intake and exhaust ventilating system which utilizes a labyrinth baffling system to remove contaminants before air reaches motor interior. Incoming air is required to make a series of right-angle turns and reductions in velocity before entering motor interior.

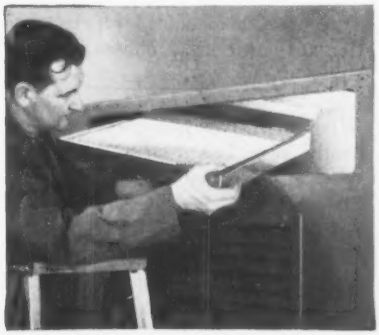
The new design, developed in G.E.'s Medium AC Motor and Generator Dept. to meet or exceed NEMA Type II definition, has passed a series of "hurricane tests," during which tons of water were hurled on the motor at wind velocities up to 100 mph. At completion of tests no moisture had entered the motor interior. Danger of pressure build-ups during severe storms is reduced by special "blow-through" passages for high velocity winds.

FOR MORE INFORMATION on this modern motor design, consult your nearby G-E Apparatus Sales Office or write to Medium AC Motor & Generator Dept., Section 882-7, General Electric Co., Schenectady, N. Y.

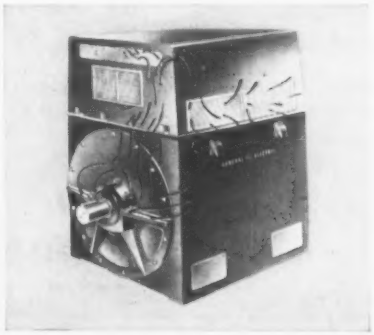
Progress Is Our Most Important Product

GENERAL ELECTRIC

BETTER PROTECTED AIR OPENINGS—"High up" air intake passages of new G-E motor prevent snow, trash, dust or dirt from being drawn into motor. Passages do not clog. Side intake and end exhaust prevent recirculation, allowing side-by-side mounting with minimum spacing.



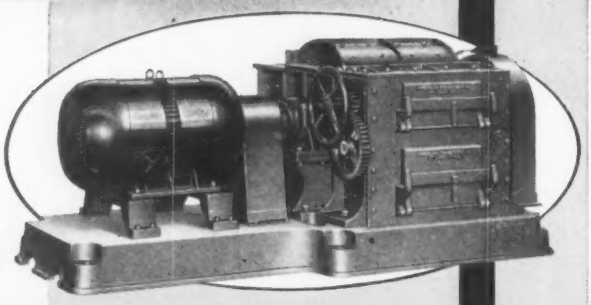
TOP ACCESSIBILITY—Air passages in top section are completely accessible through nine openings. Filter installation, inspection or replacement is fast and easy.



EFFECTIVE DIRT REMOVAL—Ventilating system of new Weather Protected Motor prevents dirt, moisture and other contaminants from entering motor interior.

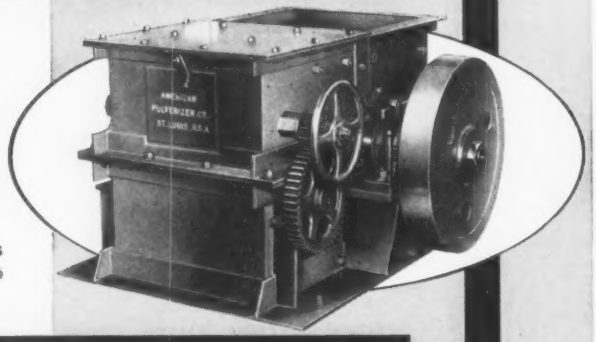
SIMPLIFIED MAINTENANCE—Removable, lightweight end shield permits complete accessibility to motor interior and bearings without disturbing alignment.

When You Figure . . .



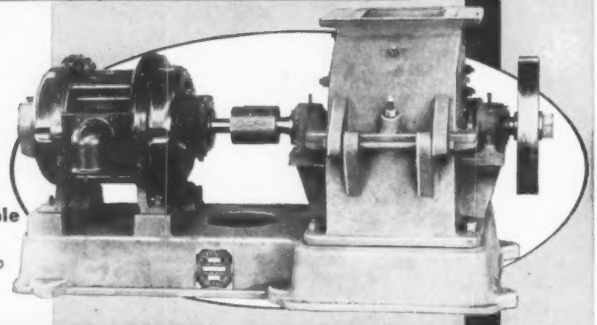
AC Series
capacities to
800 TPH

Reduction
Cost Per Ton . . .



WC Series
capacities to
90 TPH

the Best Answers*. . .



Coal Sample Crushers
capacities to
2000 Lbs.
Per Hr.

Come from *American*
Ring Coal Crushers

*In a recent independent survey, it was found that American Crushers reduced over 61,000,000 tons of coal at a parts replacement cost (including standby parts) of *less than 1/10th of 1¢ per ton.*

THERE CAN BE NO BETTER PROOF OF AMERICAN QUALITY!

American
PULVERIZER COMPANY

WRITE for Literature on These Crushers

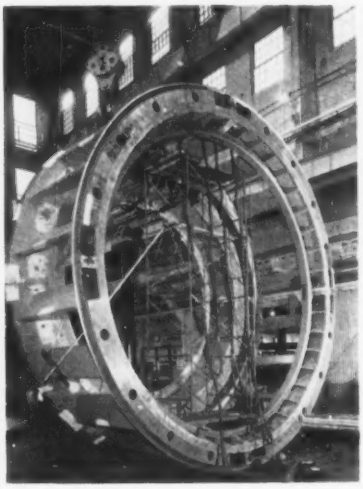
Designers and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • ST. LOUIS 10, MO.

Reports from the field

Begins on page 158

three-unit installation at Detroit Edison's River Rouge power plant is scheduled to go into operation in April. Capacity of the Detroit Edison electrical system passed the 3-million-kw mark with installation of the second unit last November. These turbine-generators are some of the world's most powerful; the second one is producing 260,000 kw, and number three is slated to have a 320,000-kw output.



Stay-discharge ring to go in giant turbine

Dwarfing its surroundings, combination stay and discharge ring has an overall diameter of 28½ ft. Shown during construction in Allis-Chalmers shops, ring will be part of a single vertical francis-runner hydraulic turbine for Washington Power Co's Noxon Rapids hydro project.

Runners for 130,800-hp 152-ft-head hydraulic turbines will be among largest of francis type ever built. Turbines are scheduled for installation at Clark Ford, Montana in 1959.

Wisconsin Electric Power Co recently placed a fourth generating unit in operation at its Oak Creek plant and has started excavation for a fifth. Capacity is now 500,000 kw. Construction of an addition to house a 250,000-kw steam generator is currently underway. Units are Allis-Chalmers close-coupled cross-compound turbine generators.

proportional positioning

HEART OF THE PROCESS CONTROL SYSTEM

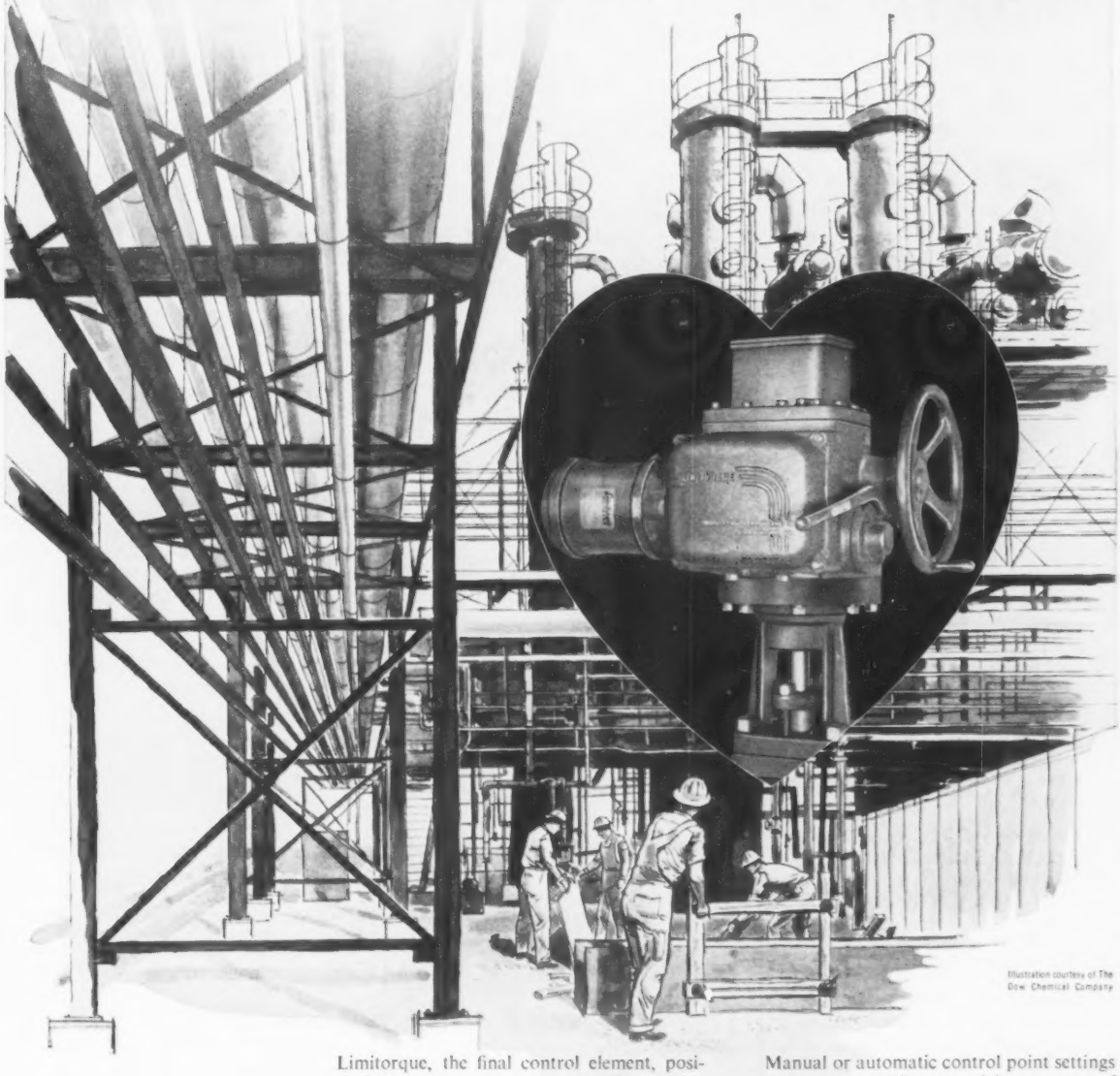


Illustration courtesy of The Dow Chemical Company

LimiTorque converts any variable into a constant...

Limitorque, the final control element, positively converts any up-stream process variable into a down-stream constant by continuously repositioning the control valve.

LimiTorque can be adapted to any control signal given by existing process control equipment and transducers.

Complete control systems are available from LimiTorque, and the components employed in the systems are chosen for dependability, with the elimination of complex circuits and special power supplies, and ease of maintenance.

Manual or automatic control point settings may be made in the control instruments of these systems and thus the required final control position is assured in proportional relationship to variations in the measured conditions.

The demand for centralization of performance responsibility in a single source, for complete process control system, is more than adequately met by these modern all electric actuator systems.

For more detailed information, write for Bulletin #6-57.

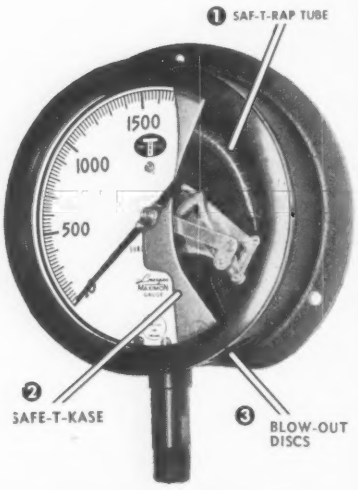
LimiTorque®

PHILADELPHIA GEAR WORKS, INC.
ERIE AVE. & G STREET, PHILADELPHIA 34, PENNA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

"TRIPLE-THREAT" SAFETY...



LONERGAN'S NEW SAF-T-RAP® PRESSURE GAUGES

1 New SAF-T-RAP Tube . . . special industrial tape wrapping which confines or smothers explosive effect when tube is ruptured.

2 New SAF-T-KASE places an armor plate between dial and tube and movement assembly—thereby containing any explosive force within the cast housing.

3 New BLOW-OUT DISCS (Safety Vents) . . . provide positive insurance against any pressure build-up within the gauge . . . slightest pressure causes plugs to drop out.

Another big plus feature for new Lonergan SAF-T-RAP Gauges is *bored steel tubing*, carbon or stainless . . . a special machine *rifle bores* the tubes, producing a "mirror-like" finish which decreases the possibility of rupture and adds to the life of the gauge (it has been proved that tubes will often rupture at the point where there is a tool-score).

And, all of these features for greater safety and longer life are available with Lonergan SAFE-T-KASE Gauge with SAF-T-RAP Tube. Write for further details.

ESTABLISHED 1872

Lonergan

E. LONERGAN COMPANY

2nd and Race Streets
Philadelphia 6, Pa.

Appointments

Executive changes

Westinghouse Electric Corp: Gwilym A Price, chairman of board; Mark W Cresap Jr, president and chief administrative and operating officer; E V Huggins, chairman of executive committee and vice-president; John K Hodnette, executive vice-president.

Kaiser Engineers, div of Henry J Kaiser Co: David F Shaw, vice-president. **Minneapolis-Honeywell Regulator Co:** Walter W Finke, vice-president. **Babcock & Wilcox Co:** Paul H Setzler, vice-president and head of Manufacturing Dept of Boiler Div. **Norden-Ketay Corp:** Wladimir A Reichel, senior vice-president.

Operations changes

General Electric Co: Robert A Slater, manager of manufacturing engineering in Metallurgical Products Dept. **Allis-Chalmers Mfg Co:** J V McGuire, assistant general manager of Pittsburgh Works; H P Pinkham, assistant general manager of Boston Works. **De Laval Steam Turbine Co:** Donald T Bixby, assistant manager of Standard Products Div.

Square D Co: Paul A Christenson, works manager of Industrial Controller Div. **Lamson Corp:** William A Lewis, manager of production planning. **The Texas Co:** Russell F Dorsch, superintendent of Jacksonville Terminal.

General sales manager

Dominion Bridge Co, Ltd: George H Midgley: expanded duties in policy development. **Darling Valve & Mfg Co:** M W Hartman, Darcova Div. **Allis-Chalmers Mfg Co:** J D Harmison, material handling, Buda Div. **General Electric Co:** Edward K How, standard lines, Conduit Products Dept.

District sales manager

General Electric Co, Large Steam Turbine-Generator Dept: Leland D Whitescarver, Region Three; Russell W Miller, Region Four. **Lunkenheimer Co:** George W Lambertson,

Abbott's
NATIONAL ELECTRICAL CODE HANDBOOK

The electrical contractor's job book completely revised to conform with the 1956 Code requirements and planned to enable electricians to understand and work in accordance with the National Electrical Code. Wherever a ruling in the Code lacks clarity, it is carefully reviewed and its application explained. **New 9th Edition revised by Charles L. Smith. Protect. Ass. 642 pp., 394 illus., $8.00**

JUST OUT

PUMP OPERATION AND MAINTENANCE

Shows plant operating and management personnel how to operate and maintain pumps used in industrial, municipal, central-station, marine, institutional, and similar installations. Every major class and type of pump is covered, with specific instructions for installing, starting up, routine operation, periodic maintenance, and major overhaul. **By Tyler G. Hicks, Mech. Engr., formerly Assoc. Ed., Power. 310 pp., 383 illus., $9.00**

INTRODUCTION TO HEAT TRANSFER

Shows how to solve heat transfer problems in the fields of aeronautics, and chemical, electrical, and mechanical engineering. Covers heat transfer fundamentals, applying calculations to design of feed-water heaters, condensers, boilers, internal-combustion engine cylinders, and fan coils. **New 3rd Edition. By Aubrey I. Brown and Salvatore M. Marco, Dept. of Mech. Engrg., Ohio State U. 328 pp., 70 illus., $6.75**

JUST OUT

MANAGEMENT FOR ENGINEERS

Provides the engineer with the know-how for undertaking management relations and responsibilities. Chapters discuss production costs and their control; the basic financial transactions of a business enterprise—insurance, depreciation, taxes, power, labor, materials, etc.; and the higher level decision-making process. **By Roger C. Heimer, Villanova Univ. 453 pp., $6.75**

SEE THESE BOOKS 10 DAYS FREE

McGraw-Hill Book Co., Dept. P-3
327 W. 41st St., New York 36, N. Y.

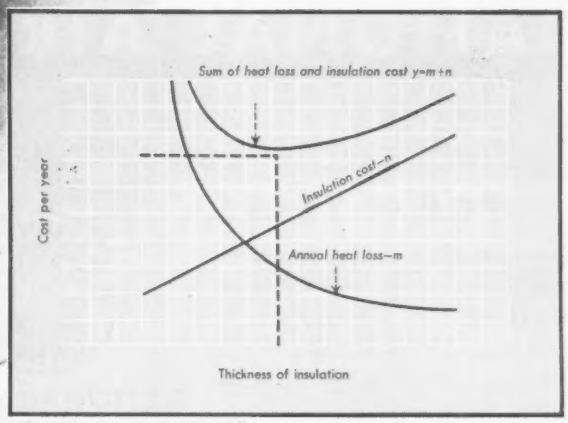
Send me book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery costs, and return unwanted book(s) postpaid. (We pay delivery costs if you remit with this coupon—same return privilege.)

☐ Abbott—Natl. Elect. Code Hdbk., $8.00
☐ Hicks—Pump Operation and Maint., $9.00
☐ Brown & Marco—Intro. to Heat Trans., $6.75
☐ Heimer—Management for Engineers, $6.75

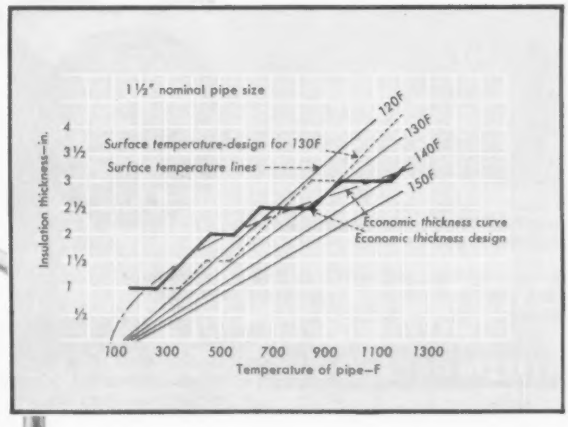
(PRINT)
Name .....
Address .....
City ..... Zone ..... State .....
Company .....
Position .....

For price and terms outside U. S. write McGraw-Hill Int'l., N.Y.C. P-3

A. I. A. File No. 37-



Above graph shows that as insulation thickness increases, insulation cost increases and heat loss cost decreases. The sum of these two shows the most economical thickness. Greater or lesser thickness costs more money.



In this example, graph shows that below 1000F more insulation is justified than cold surface temperature design indicates. Above 1000F less insulation would be used.

"COLD SURFACE" CRITERION WASTES MONEY!

How J-M engineers determine economic insulation thickness

to give you more for your insulation dollar

OVER-ALL cost of the operation should always be the determining factor in selecting insulation thickness. Yet, millions of dollars have been wasted because of rigid adherence to the cold surface temperature method. When Johns-Manville insulation is applied, J-M engineers carefully determine which thickness will provide the greatest operational savings. And this "economic thickness" is usually more (or less) than the cold surface method indicates.

Here's how it works. The annual cost of the heat loss through the insulation is plotted for various thicknesses. Also plotted is the annual cost of insulation. A third curve is then drawn as the sum of heat loss and insulation cost. The economical thickness is found where this third curve reaches its lowest point.

To arrive at the above figures in a given instance requires the following: 1. Cost of heat production per million Btu; 2. Rate of heat loss through insulation in Btu per unit area per hr; 3. Annual hours of operation; 4. Applied cost of insulation per unit area; 5. Rate of amortization and required return on the insulation investment cost. Items 2 and 4 are available from the insulation manufacturer; others are normally supplied by the plant engineer.

For more complete information, call or write Johns-Manville, Box 14, New York 16, New York. In Canada, Port Credit, Ontario. Ask for reprint of technical article "Select Economic Insulation Thickness."

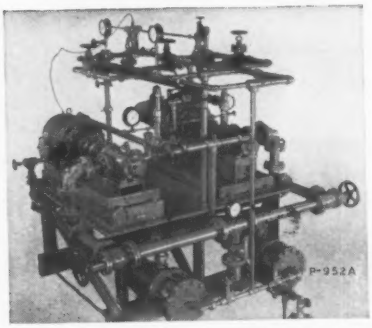
JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

NATIONAL AIROIL

SERVING INDUSTRY'S COMBUSTION REQUIREMENTS FOR 46 YEARS

NATIONAL AIROIL
FUEL OIL PUMPING and HEATING UNITS



P-952A—Steam Turbine and Electric Motor drive gives flexibility in this compact Model P-ES2H size No. 25 unit.

Complete range of sizes and models in both medium and high pressure types . . . *more compact than ever!* Write for Bulletin 40.

NATIONAL AIROIL
COMBUSTION ACCESSORIES

AIR CONTROL DOOR and FRAME

FUEL-OIL SUCTION STRAINER

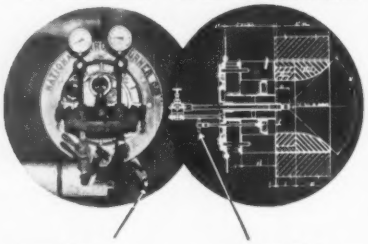
WIDE VIEW PEEPHOLE

IGNITION PORT

FURNACE RELIEF and ACCESS DOOR

These and other "accessory items" for every industrial liquid fuel-gas installation. Ask for Brochure No. 10.

NATIONAL AIROIL
UNIVERSAL REGISTERS with TYPE "SA" OIL BURNERS



Control for Air Vane

Control for Refractory Faced Disk

BETTER PERFORMANCE with NATIONAL AIROIL Universal Registers because they have a DUAL FEATURE for controlling air volume independent of turbulence. Air vanes can be instantly reversed to change direction of turbulence while air volume is separately regulated by a refractory faced disc control. Both adjustments can be made while the burner is firing.

Another "dual advantage" of NATIONAL AIROIL Universal Registers is that they are equipped for dual fuel firing of gas and oil. Universal Registers with burners are available in three (3) sizes . . . capacities up to 60,000 lbs. of steam produced per burner per hour. Write for Bulletin 51.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes
STEAM ATOMIZING OIL BURNERS
SLUDGE BURNERS, Steam Atomizing
MOTOR-DRIVEN ROTARY OIL BURNERS
MECHANICAL PRESSURE ATOMIZING OIL BURNERS
DUAL STAGE, Combining Steam and Mechanical Atomization
LOW AIR PRESSURE OIL BURNERS
AUTOMATIC OIL BURNERS, for small process furnaces and heating plants
GAS BURNERS
COMBINATION GAS & OIL BURNERS
FUEL OIL PUMPING and HEATING UNITS
FURNACE RELIEF DOORS
OBSERVATION PORTS
SPECIAL REFRACTORY SHAPES

NATIONAL AIROIL BURNER CO., INC.

Main Office and Factory: 1250 EAST SEDGLEY AVE., PHILADELPHIA 34, PA.

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

More Appointments

Begins on page 234

divisional sales manager; Jack W Montgomery, Chicago.

Bailey Meter Co: G R Mays, Chicago; J O Meals, St Louis; J W Roth, Los Angeles. **American Air Filter Co, Inc:** Frank K Platt, central region. **The Garlock Packing Co:** James H Munger, Indiana. **Baldwin-Hill Co,** Industrial Insulation Div: T J Callans, eastern area.

Allis-Chalmers Mfg Co, Industries Group: R E Morris, St Louis; W P Bell, Washington, D. C.

Institute elections

The American Society of Mechanical Engineers: O B Schier II, secretary. **American Institute of Mining, Metallurgical and Petroleum Engineers, Inc:** Dr Augustus B Kinzel, president; Howard C Pyle, president-elect; Arthur W Thornton and John C Kinnear Jr, vice-presidents. **National Electrical Manufacturers Assn:** W V O'Brien, president.

Diesel Engine Manufacturers Assn: Guy J Coffey, president. **Edison Electric Institute:** J W McAfee, president; J E Corette, vice-president.

Polytechnic Institute of Brooklyn: Dr Ernst Weber, president. **Battelle Memorial Institute:** Dr B D Thomas, president.

Institute awards

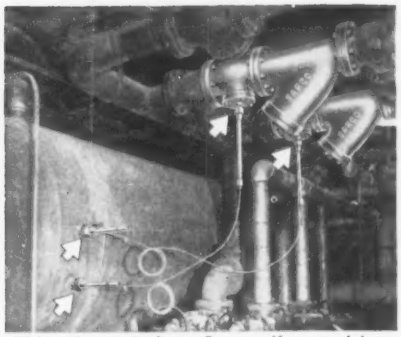
E G Bailey, founder of Bailey Meter Co, received Honorary Membership, highest award of American Society of Mechanical Engineers.

Alvin N Gray of Western Electric Co received Manufacturers Medal of National Electrical Manufacturers Assn.

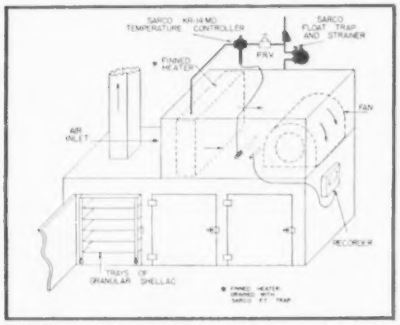
John K Hodnette of Westinghouse Electric Corp received 1957 Edison Medal of American Institute of Electrical Engineers.

J Roy Gordon of The International Nickel Co, Inc, received James Douglas Gold Medal for 1958 awarded by the American Institute of Mining, Metallurgical and Petroleum Engineers.

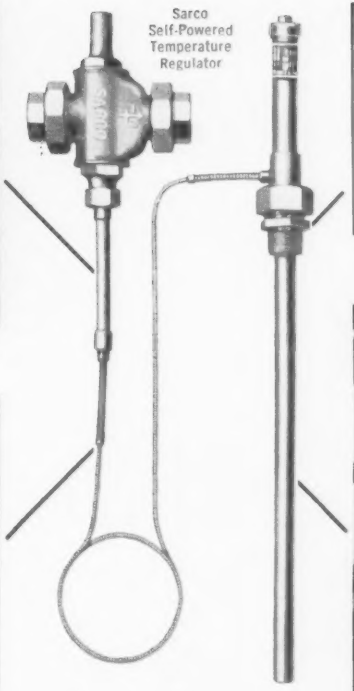
A C Buensod, late chairman of Buensod-Stacey, Inc: grade of Fellow of the American Society of Heating and Air-Conditioning Engineers.



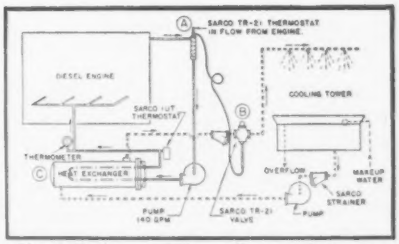
Water storage tanks — Sarco self-powered temperature controls on service water storage tanks from twin heaters.



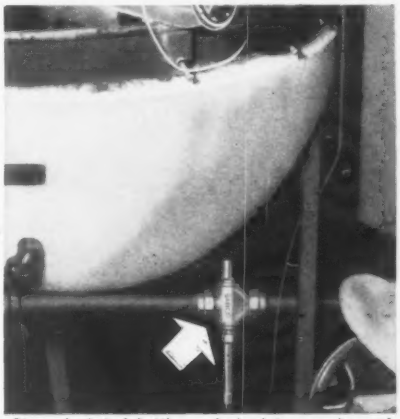
Shellac dryer — even temperature maintained; moisture uniformity of granular shellac accurately controlled — by Sarco self-powered temperature control.



FOR YOUR INDUSTRY
Chemical Processing • Metalworking
Food • Textile • Paper
Oil Refining • Others



Diesel Engine — Sarco self-powered temperature controller used on diesel engine cooling system. Also ideal for compressors.



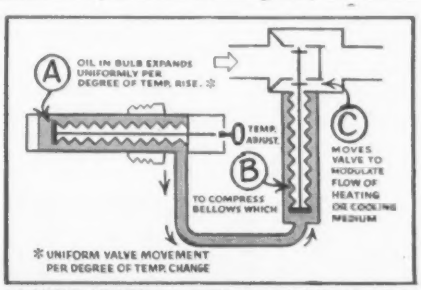
Steam-jacketed kettle — desired temperature of kettle content is automatically maintained by Sarco self-powered temperature control. Steam waste, uncertainty of manual control eliminated.

How to get Automatic Temp. Control that's simple, dependable, inexpensive

HERE'S the way to get rid of uncertain, time-wasting manual temperature control . . . *throughout* your plant. And without investing in complicated, costly temperature control equipment.

These SELF-POWERED Sarco controls are inexpensive, simple, dependable, accurate. They can be used for 85% of your jobs. ½" size costs only about $100!

Thousands of these Sarco controls are giving dependable, accurate service for firms such as Colgate-Palmolive Co., Sinclair Refining Co., Swift and Co.


A
OIL IN BULB EXPANDS UNIFORMLY PER DEGREE OF TEMP. RISE. *
TEMP. ADJUST.
B
TO COMPRESS BELLOWS WHICH
C
MOVES VALVE TO MODULATE FLOW OF HEATING OR COOLING MEDIUM
* UNIFORM VALVE MOVEMENT PER DEGREE OF TEMP. CHANGE

AS SIMPLE AS ABC . . . that's Sarco Self-Powered Temperature Control. A thermostat with capillary tubing and a valve . . . that's all there is to it!

SARCO SELF-POWERED TEMPERATURE CONTROLLERS
—need no power source

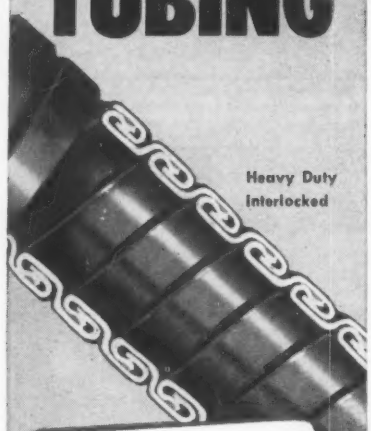
1. Self-Powered — no compressed air or electricity needed.
2. Easy to install — by any pipe-fitter.
3. Self-contained — no exposed mechanism. Packless valve.
4. Simple — no gadgets that take a technician to read and repair.
5. Not affected by cross-ambient temperatures or elevation of the bulb.

Send for Bulletins: No. 620—Self-powered Temperature Controls. No. 710—Self-powered Cooling Controls. No. 1025—Electric Indicating Temperature Controls. Sarco Company, Inc., 635 Madison Avenue, New York 22, N. Y. 2208-B

SARCO
Automatic Temperature Control

ELECTRIC INDICATING AND SELF-POWERED TEMPERATURE CONTROLLERS • STEAM TRAPS • STRAINERS

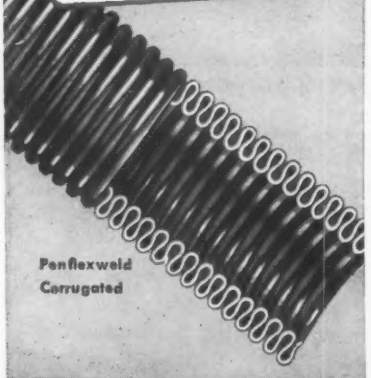
FLEXIBLE TUBING



RUGGED AND STRONG FOR LASTING SERVICE

. . . that is Penflex Flexible Tubing. Especially engineered for punishing industrial service . . . to defy abrasion, crushing, heat in conveying liquids, chemicals, powders, granular materials, semi-solids.

Penflex makes all types and sizes (1/8" to 24" I.D.) for every industrial application. For complete data, write . . . Pennsylvania Flexible Metallic Tubing Company, Inc., 7237 Powers Lane, Phila. 42.



PENFLEX

TIGHT AS A PIPE BUT...

FLEXIBLE

Bookshelf

Patent Notes for Engineers (7th Ed.) *By C D Tuska, Director of Patent Operations, RCA Laboratories, Princeton, New Jersey. 192 pp, 6 x 9, cloth. $4.00. McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y.*

This book bridges the gap between engineers and patent attorneys. Patentable inventions are defined and methods of protecting them explained. Employer - employee relationship in patent matters is covered.

Chapters cover preparation of patent applications, patent office filing procedure and what happens when rival inventions are placed in interference.

Actual case histories are quoted and court decisions cited to clarify some of the typical problems. Patent illustrations, disclosure drawings and sample application forms are given.

Mr. Tuska's book erects clear warning signals along the inventor's path from original idea to ownership of a patent. These warnings can make the difference between getting wisdom by bitter experience and successfully obtaining valuable patents.

Electrical Systems Design. *By Joseph F McPartland and editors of* Electrical Construction and Maintenance. *140 pp, 8½ x 11, illust. $6.00. McGraw-Hill Book Co, 330 W 42 St, New York 36, N. Y.*

A practical manual on design and layout of electrical systems for power, light, heat, signals and communication in industrial, commercial and residential buildings, this book presents latest practice in readable, easy-to-understand style. Frequent reference is made to appropriate regulations of National Electrical Code. Recognition of substantial spare capacity as an essential element of modern electrical design influences the treatment. Calculations are made by practical formulas given in tabular form. Graphical symbols, conversion factors and reference data included.

John I Yellott has resigned as an assistant director of Stanford Research Institute to devote full time to his duties as executive director of the Association for Applied Solar Energy in Phoenix, Ariz.

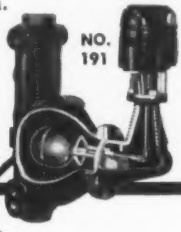
McDonnell Answer

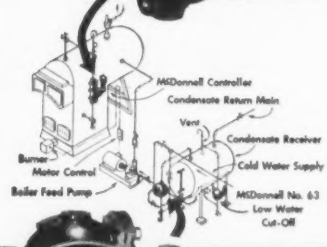
. . . for boilers up to 150 psi

McDONNELL No. 191
Water Column Type Pump Control
Cut-off and Alarm Switch

Controls the boiler feed pump the one right way—from the boiler water level itself. Introduces new repulsion magnetic switching for positive opening *and* closing. Quality is attested by its use as standard equipment on many fine "package" boilers. Other repulsion switching types for boilers up to 250 psi.

Underwriters' Listed
C. S. A. Approval No. 5545





McDONNELL No. 27T MAKE-UP WATER FEEDER

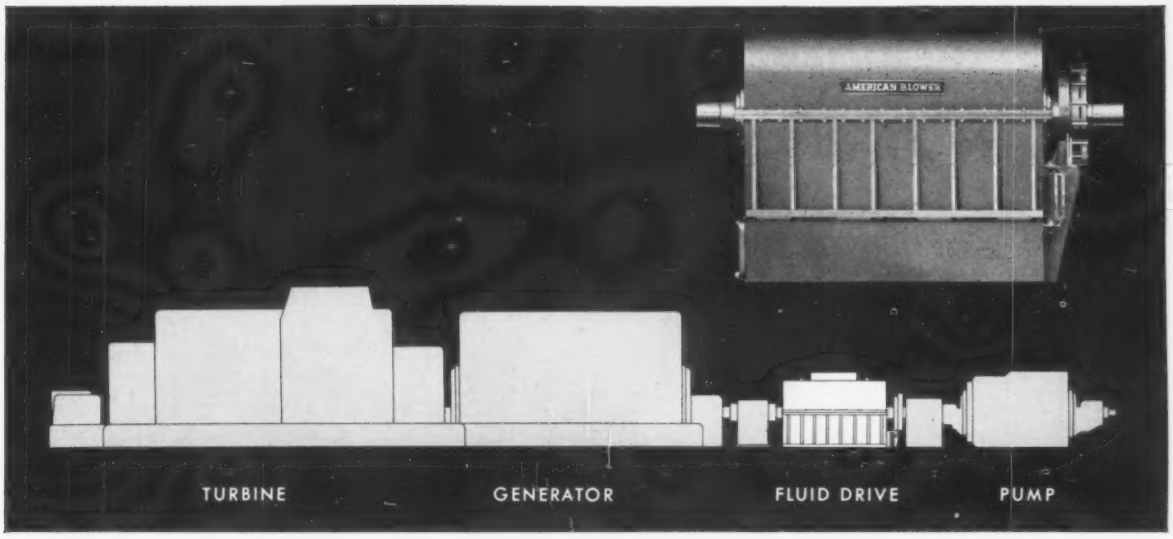
Automatically adds water to condensate receiver to make-up for any defficiency in returns. Has large feeding capacity to meet any sudden boiler demand. Stainless steel needle and seat assure drip-tight closing. For tank pressures to 35 psi., supply pressures to 100 psi.

Write for Bulletin L-123

McDONNELL & MILLER, Inc.
3506 N. Spaulding Ave., Chicago 18, Illinois

Doing One Thing Well

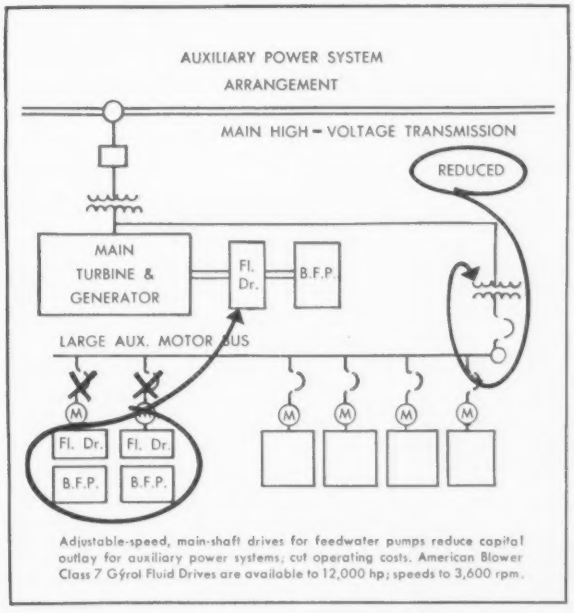
McDONNELL
Boiler Water Level Controls and Safety Devices



American Blower *Gýrol*® Fluid Drive lets you:

Take boiler feed-pump power from main-turbine shaft . . . slash auxiliary costs!

Save price of motors, switchgear, conduit and cable. Release more power to consumer lines. Reduce operating costs.



Adjustable-speed, main-shaft drives for feedwater pumps reduce capital outlay for auxiliary power systems; cut operating costs. American Blower Class 7 Gýrol Fluid Drives are available to 12,000 hp; speeds to 3,600 rpm.

Savings of nearly $500,000 are predicted for two new 290-Mw units scheduled for service this year. Both use main-turbine feedwater pumps driven through American Blower adjustable-speed Gýrol Fluid Drives.

Savings are threefold:

1. **Shaft-end pumps eliminate costly electrical accessories necessary for motor-driven feed pumps.**
2. **Auxiliary demands are reduced, so more power can be released to consumer lines.**
3. **American Blower Gýrol Fluid Drive saves power over the entire operating range. It offers adjustable-speed pump control that eliminates wasteful throttling; reduces wear by operating pumps at speeds to fit boiler demands.**

In addition, paralleling of pumps is simplified with Gýrol Fluid Drive. Emergency changeover from operating to standby pump is easily accomplished.

Let an American Blower sales engineer show you how Gýrol Fluid Drive can save power, cut costs . . . improve operating efficiency. Contact our nearest branch office, or write: American-Standard,® American Blower Division, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ontario.

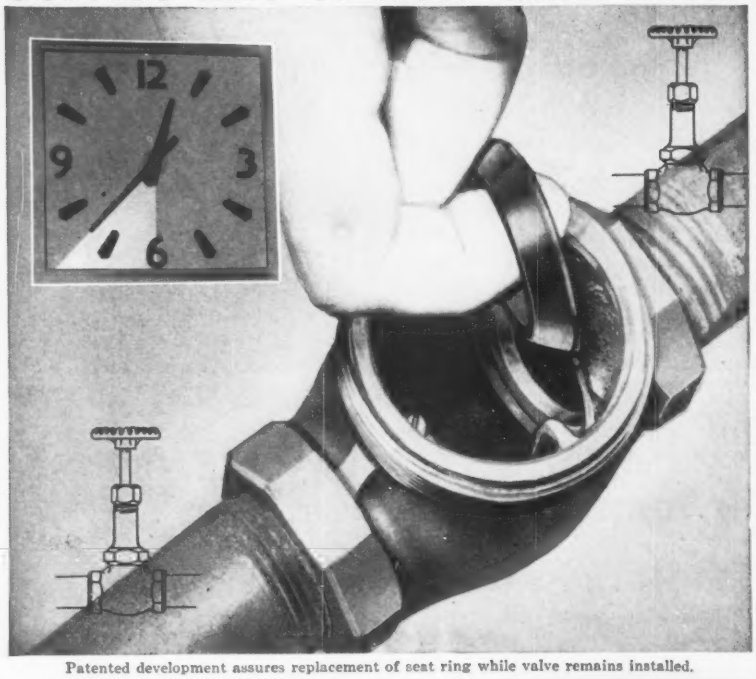
® American-Standard and Standard are trademarks of American Radiator & Standard Sanitary Corporation.

American-Standard Products

AMERICAN-Standard

AMERICAN BLOWER DIVISION

Only 7 to 10 Minutes to Renew Service Life of New Gate Valve



Patented development assures replacement of seat ring while valve remains installed.

Without removing the valve body from the line, you replace the nickel-alloy seat rings in Fairbanks new patented Renewable Seat Ring Gate Valves. In 7 to 10 minutes, from the time the line is shut down until it is put back into operation, you have given a new service life, a new life of dependable tight closure to your valve.

Just 7 to 10 minutes of your maintenance man's time — only 7 to 10 minutes of "down-time" on your steam, water or process piping lines — and you have the equivalent of a new valve in the line. Think of the savings: where once at least one hour, under the most ideal conditions, was required to replace a gate valve in the line, the job is now accomplished in from 7 to 10 minutes.

Field tested for over two years, under all conditions from steam to corrosive liquids, the revolutionary new Fairbanks Renewable Seat Ring Bronze Gate Valve has proven completely satisfactory — absolutely dependable.

Made with either rising stem or non-rising stem construction in ½",¾",1", 1¼", 1½" and 2" sizes, the Fairbanks Renewable Seat Ring Bronze Gate Valves are recommended for severe service conditions on 200 lb. steam pressure at 550 degrees F., 400 lb. water, oil or gas pressure — non-shock — lines requiring full flow and subject to frequent operation. Nickel alloy seat rings and wedge make the valves particularly tough and corrosion resistant.

YOURS ON REQUEST: Illustrated, descriptive folder gives complete information on Fairbanks Renewable Seat Ring Gate Valve with details and specifications. Yours without charge. Write today.

1. Union Bonnet removed. Retaining screw loosened with ordinary screwdriver.

2. Finger hooks inside nickel alloy seat ring. Seat ring lifts out of valve body.

3. New seat ring is inserted. Retaining screw tightened. Bonnet replaced.

THE **Fairbanks** COMPANY
393 Lafayette Street, New York 3, N. Y.
Branches:
New York 3 • Boston 10 • Pittsburgh 22 • Rome, Ga.
Valves • Trucks • Casters • Wheels • Dart & "PIC" Unions

Technical briefs

Begins on page 160

Testing

Ultrasonic testing of large rotor forgings . . . criteria for detecting ability. *By S Serabian and G E Lockyer, General Electric Co*

Operating stresses in large steam turbine-generator rotor forgings have gradually increased in recent years, and need has grown for testing methods to determine necessary forging quality. At present, the only non-destructive means for detecting internal imperfections in such forgings is by ultrasonic testing.

Forging quality has improved since ultrasonic testing was first introduced. In the early stages, discontinuities were comparatively large, with dense distributions. Today they are smaller and more widely scattered, and an appraisal of inspection techniques is advisable if ultrasonics is to continue to show the way toward further forging improvement.

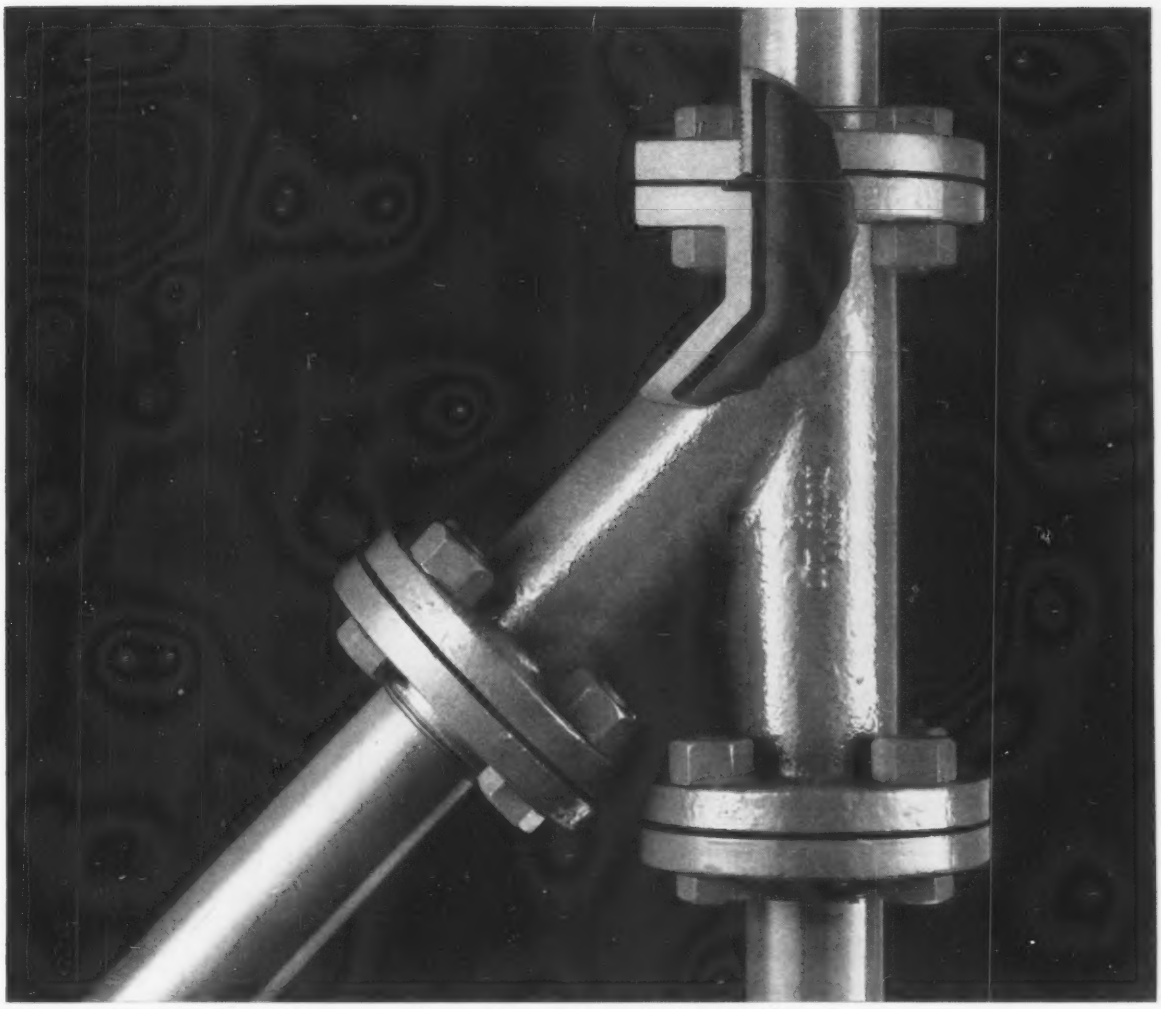
The purpose of this paper is to evaluate ultrasonic inspection techniques in terms of the quality of rotor forgings available today. In particular, the implications of beam width, and frequency in conjunction with the dispersive action of the discontinuity are examined. *ASME paper, No. 57-A-279*

Ultrasonic detection of thin laminar inclusions. *By S Serabian and C D Moriarty, General Electric Co*

Ultrasonic inspection is one of the most sensitive tests that can be applied to material. In fact, its ability to detect thin laminar flaws, when X-ray failed to do so, brought it into prominence as an inspection tool for wrought material. In the X-ray transmission method, the lower limit of inclusion thickness detectability is a function of X-ray wave length and composition of the inclusion. What has apparently not been fully appreciated is that in the ultrasonic reflection method, the lower limit of inclusion thickness detectability is also a function of wave length and composition.

This paper reports on an investigation of the effect of thickness and composition of an inclusion on its ultrasonic reflectivity. The investiga-

Directions for ordering papers on page 244



Cutaway view shows how corrosive liquids are prevented from touching metal in Saran lined pipe and fitting.

Here's why power engineers specify Saran lined pipe

It's rigid steel pipe lined with Saran . . . will not react with acid or chemically pure water

Power engineers are using more and more Saran lined pipe and Saraloy® 898 tank lining in water de-mineralizing systems. Tough, corrosion-resistant saran is an inert material that won't react with chemically pure water. With a complete system lined with saran and Saraloy, there is no danger of water contamination.

Pipe, valves, pumps and fittings lined with the new gray saran have many additional advantages. Its coefficient of thermal expansion more closely approaches that of its steel shell, providing a broader operating temperature range. It can be installed in systems operating from full vacuum to 300 psi and temperatures from −20°F. up to 200°F. Add to this the immediate availability from stock of Saran lined pipe, valves, pumps, fittings and Saraloy 898 tank lining and you have an ideal, reaction-free piping system.

Get all the details on why you should consider a complete system lined with saran and Saraloy. Write today. THE DOW CHEMICAL COMPANY, Midland, Michigan.

SARAN LINED PIPE COMPANY
DEPT. 2005H
2415 BURDETTE AVENUE
FERNDALE 20, MICHIGAN

Please send me information on:
☐ Saran lined pipe, fittings and valves. ☐ Saran lined centrifugal pumps. ☐ Saraloy 898 chemical-resistant sheeting.

Name_____ Title_____ Company_____

Address_____ City_____ State_____

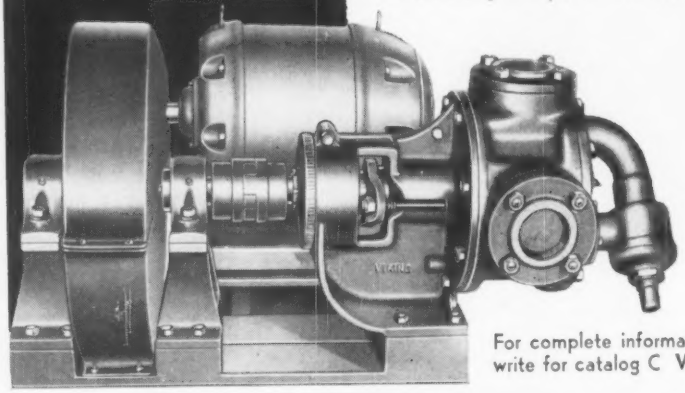
YOU CAN DEPEND ON DOW

for **RUGGED PUMPING**

Specify **VIKING** Heavy Duty **PUMPS**

When jobs require rugged pumping, you can depend upon Viking Pumps. All are fast self-priming and positive in action. Models are built to handle liquids ranging from LP-Gas up to those of a viscosity of 2,500,000 SSU.

Choose yours in sizes of 10, 20, 35, 50, 90, 150, 200, 300, 450, 750 and 1050 G.P.M. Suitable for pressures to 200 psi on lubricating liquids, or 100 psi on non-lubricating liquids. Built of many types of metals and combinations of metals. Available in any type of mounting and power desired.



For complete information, write for catalog C W.

VIKING PUMP COMPANY
Cedar Falls, Iowa, U.S.A. In Canada, it's "**ROTO-KING**" pumps
See Our Catalog in Sweet's Industrial Construction and Plant Engineer's File

Get your copy now . . .

the New "Directory of Manufacturers' Agents Serving the Power Field"

. . . contains over 2600 listings!

The largest, most complete directory of its kind

$15.00 per copy

SEND YOUR CHECK OR MONEY ORDER TO:

George Keates, Business Manager
POWER
330 West 42nd Street
New York 36, N. Y.

Technical briefs

Begins on page 160

tion deals with both the analytical and experimental approaches to the problem and discusses the resulting implications to nondestructive testing by ultrasonics. *ASME paper, No. 57-PWR-11*

Should ultrasonic inspection be used to augment radiography in the inspection of weldments in high-pressure piping. *By R L Steele, Consolidated Water Power and Paper Co*

This paper describes a procedure for the inspection of high-pressure piping weldments employing ultrasonic inspection augmented by radiography. Data presented indicate that ultrasonic inspection is superior to radiography for the detection of certain defects, but radiographic inspection of doubtful areas may be of assistance in determining the need and extent of repairs. Part 2 of the paper describes the field work and analyzes the inspector's reports. The data presented indicate satisfactory results. *ASME paper, No. 57-A-195*

Gas turbines

Gas turbines applied to power generation. *By K L Rieke and W N Hornberger, Westinghouse Electric Corp*

Gas-turbine power-generating capacity being delivered throughout the world during 1957 and 1958 is 137% of the capacity installed from the birth of the industrial gas turbine in 1945 to and including 1956. Within the Western Hemisphere, capacity to be installed in 1957-58 is 180% of that installed during the past 11 years.

In the U.S., about one-quarter of the presently installed gas turbines drive generators; the others are mechanical drive or process units.

The most popular unit has been the open-cycle gas turbine installed for peak load or standby duty, or for base load where fuel is cheap. Considerable thought has been given toward supplementing hydroelectric and steam systems with low-initial-cost gas-turbine units for peak-load applications. Capacities available for such applications vary from 2250 to 16,500 kw. The gas turbine may also

Directions for ordering papers on page 244

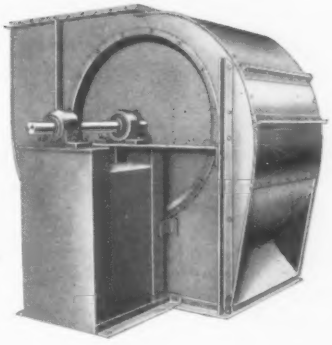
CLARAGE FANS FOR YOUR INDUSTRIAL AIR TRAVEL

Blowers and exhausters for diversified industrial applications.

Standard models promptly available.

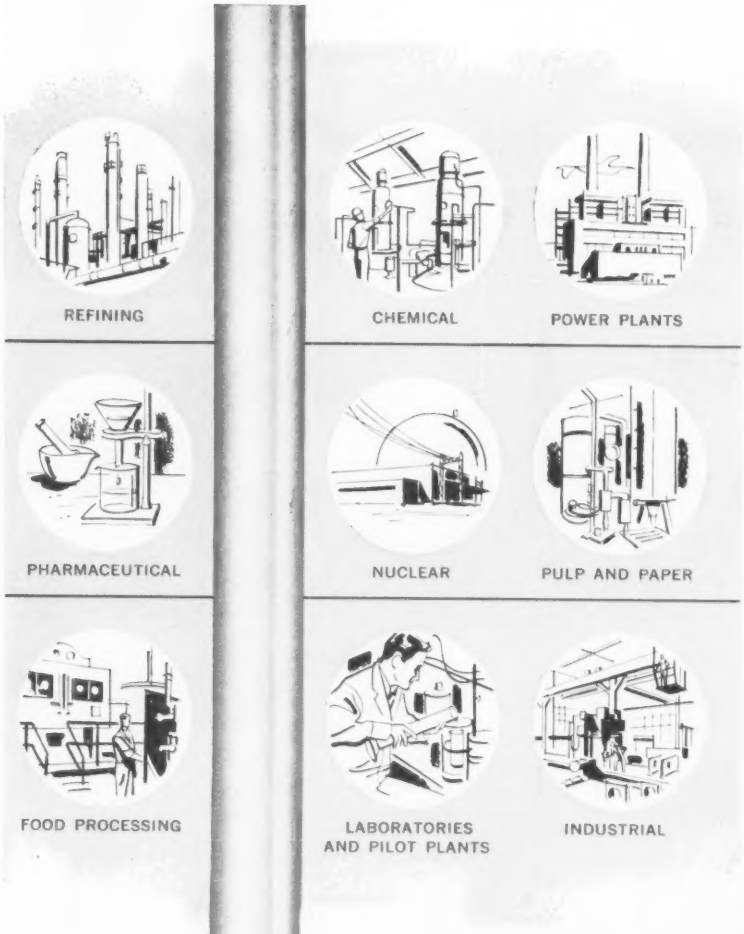
Clarage builds air handling and conditioning equipment exclusively — concentrated know-how!

When you want equipment designed and built for "the long pull"— to stretch your equipment dollar to the utmost — call on CLARAGE FAN COMPANY, Kalamazoo, Mich.



CLARAGE ... *dependable equipment for making air your servant*

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal



Where only the *finest* is good enough

Swagelok®

TUBE FITTINGS

In use wherever top performance is demanded. Swagelok Tube Fittings provide a leakproof, torque-free seal. Your Swagelok Specialist will welcome the opportunity to work with you on your particular fitting requirements. For information, write Dept. E-2.

CRAWFORD FITTING COMPANY 884 East 140th Street • Cleveland 10, Ohio

Technical briefs

Begins on page 160

be integrated into the large steam-plant capacities (100 to 200 mw) to show heat rate improvement of 5 to 6% over the steam plant alone.

The gas turbine shows its flexibility to meet specific applications in adapting the cycle to a generating-process unit power installation required in many industries (such as the paper industry), which are isolated from a convenient source of power.

Investigations of nuclear gas-turbine power are now underway. The future of the gas turbine is bright. *AIEE paper, No. CP 57-905*

A generalized presentation of gas-turbine combustor performance. *By A E Noreen and W T Martin, General Electric Co*

Experimental data on stability limits and combustion efficiency of a 3-in. diameter combustor using gaseous fuel are presented in this paper. Data has been correlated by an empirical evaluation of the results of a dimensional analysis.

Theories are proposed, based on the experimental data, regarding combustor - stabilization processes. Results show that laminar flame speed is a satisfactory index of the influence of base combustion rate on combustor performance. *ASME paper, No. 57-GTP-5*

TO OBTAIN COMPLETE TEXT

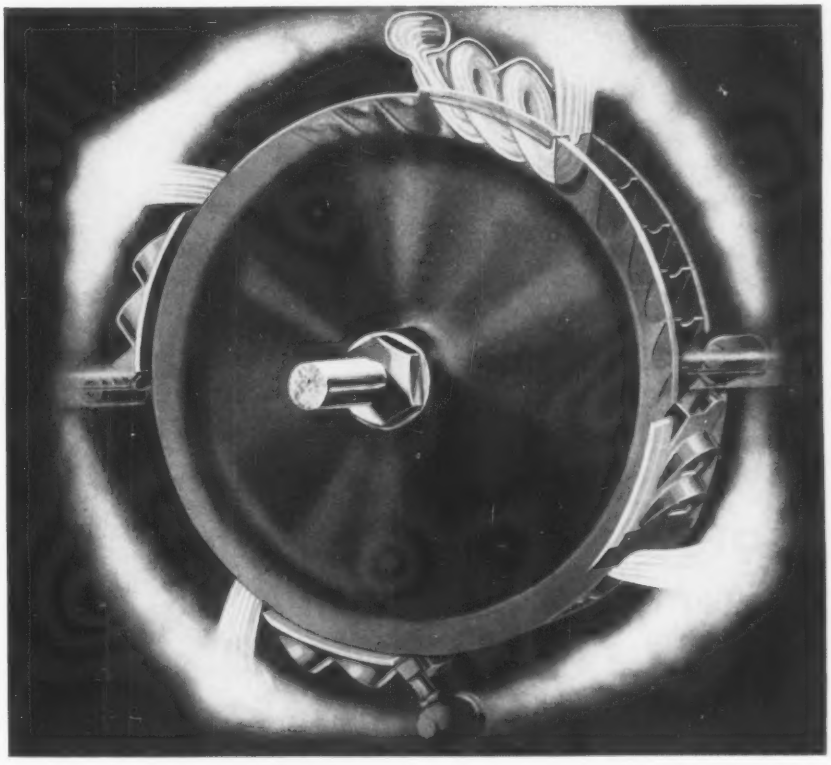
Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable from ASME, 29 W 39th St, New York 18, New York.

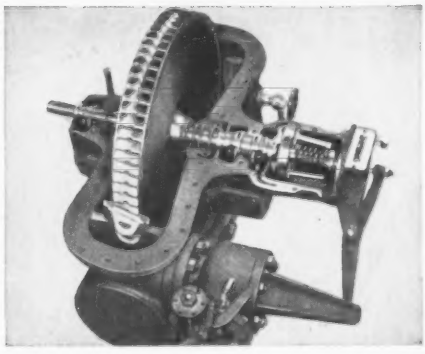
American Institute of Electrical Engineers. Identified by initials AIEE and obtainable from AIEE, 33 W 39th St, New York 18, New York.

Upping utilization factor of solid fuels in thermal power plants from current average—30 to 35%—is reportedly under study by U.S.S.R.

TURBINE BLADES CAN'T FOUL!



The Terry solid-wheel turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.



Terry solid-wheel design permits large clearances

In the Terry solid-wheel turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.

The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

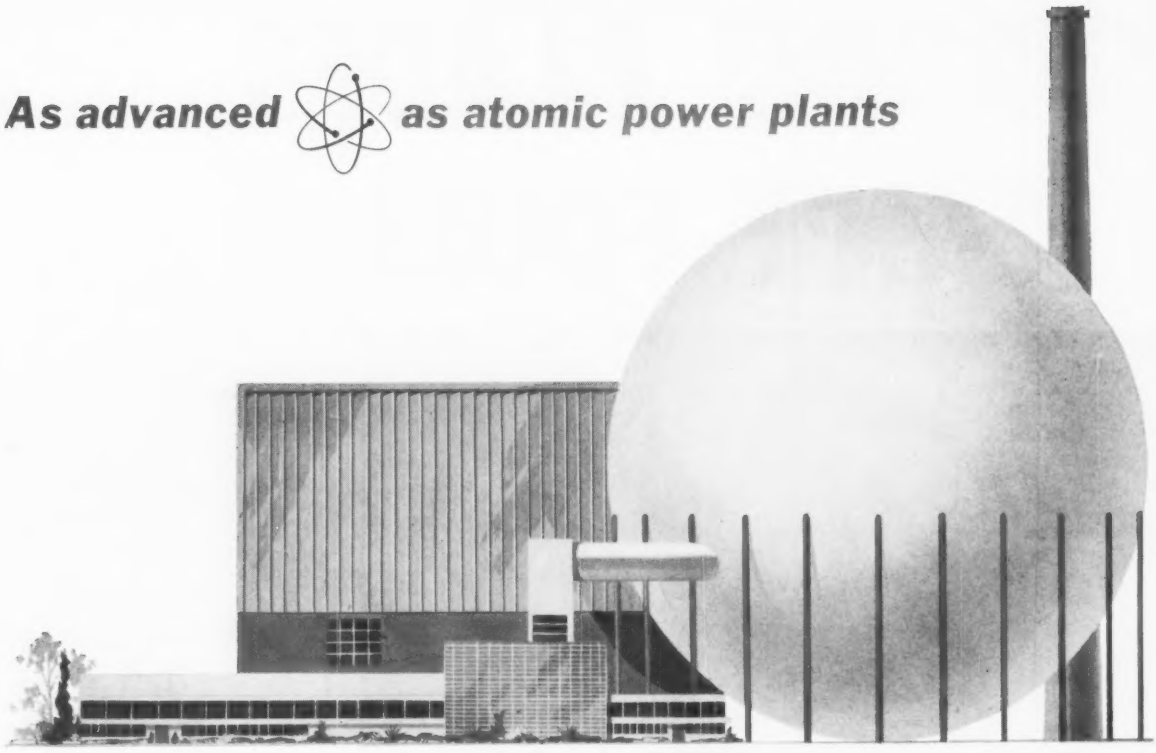
This is only one of the many advantages of Terry solid-wheel turbines. Write for complete details. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1206

As advanced as atomic power plants



INFILCO ION EXCHANGERS

treat boiling water reactor condensate at

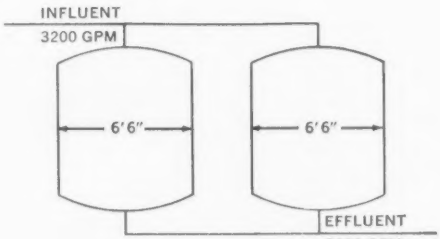
50 GPM PER SQUARE FOOT

Two 6'-6" diameter mixed bed demineralizers with a total surface area of 64 sq. ft. are now being installed to handle 3,200 gpm of reactor condensate. These units will produce polished condensate with a conductivity of approximately 0.1 micromho in a fraction of the space and at much lower installation cost than conventional equipment.

The plant design is based upon extensive pilot plant studies using a 24" diameter unit to treat unfiltered condensate at 200 gpm (68 gpm per sq. ft.). The equipment and techniques developed for this plant are also applicable to high pressure conventional and super-critical pressure plants.

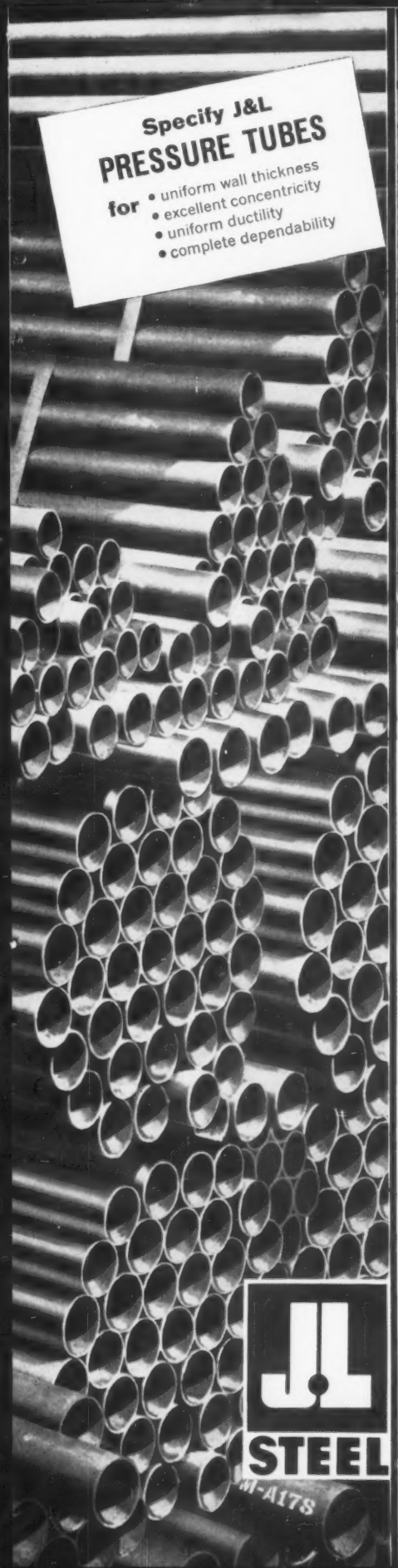
Results of pilot plant studies and design features of this ultra-modern installation will be sent free upon request. Write today for Reprint #88.

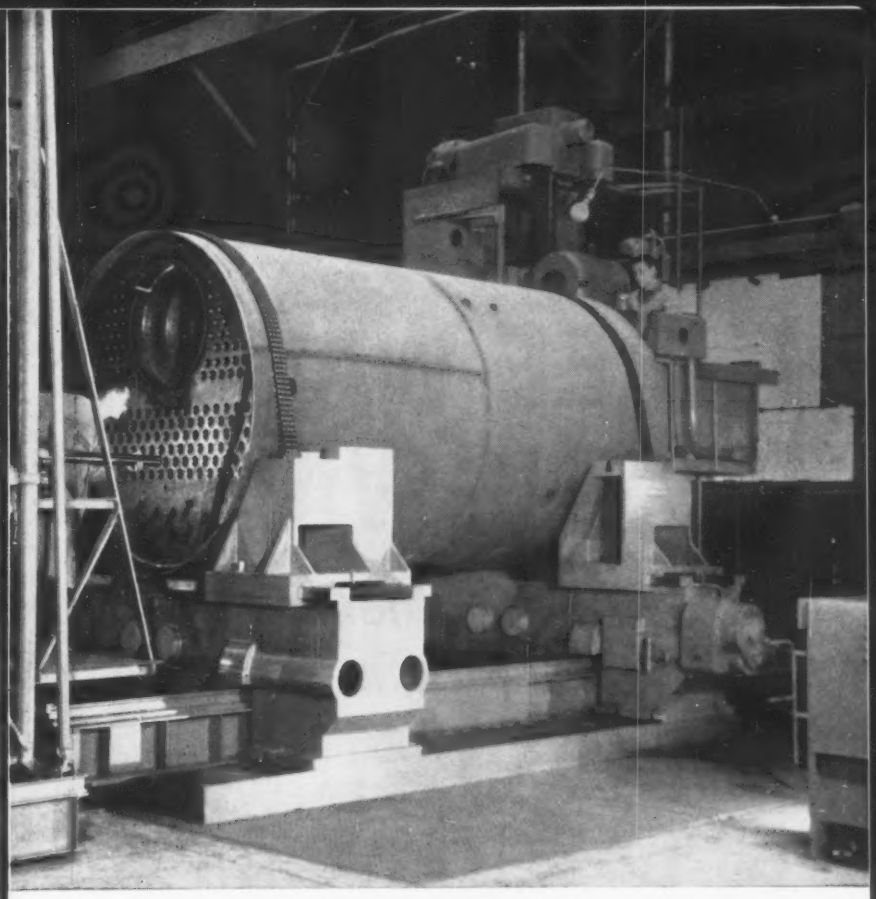
Infilco Inc., General Offices: Tucson, Arizona, P.O. Box 5033
Field Offices throughout the United States and in foreign countries.



INFILCO

THE ONLY COMPANY impartially offering equipment for ALL types of water and waste processing—coagulation, precipitation, sedimentation, flotation, filtration, ion exchange and biological treatment. 68501





J&L boiler tube uniformity speeds operations at Cleaver-Brooks

This unique "boiler-maker" at Cleaver-Brooks Company, Milwaukee, electronically drills tube sheets, rolls tubes into place, produces top quality packaged boilers. J&L boiler tube is used for this precision operation because of its concentricity, ductility and uniform thickness. Close tolerances make J&L boiler tube easy to work with minimum installation cost.

Jones & Laughlin, an integrated steelmaker, controls every step of production from iron ore to finished tubing. Most modern testing procedures at every step assure tubes with maximum strength and uniformity.

For your next order, specify J&L boiler tubes for top quality and performance. Write for the name of your nearest source, or for information on your specific requirements, to Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pa.

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

NEW

JOHNSON THREE-WAY MIXING VALVES

Beat High Installation and Upkeep Costs

The new Johnson line of Three-Way Mixing Valves for liquids offers you substantial economies in both installation and maintenance, plus design features that assure consistent, high-accuracy control performance. Here's how:

- **Piping hookup simplified**—*straightaway piping connections eliminate elbows, allow faster, easier, less costly installation.*
- **"In the line" servicing**—*discs and seat rings can be replaced without removing the valve from the line. A big time saving feature that cuts upkeep cost and eliminates unnecessary downtime.*
- **High lift**—*for precise proportioning over wider range.*
- **No leakage**—*positive seating.*
- **Modulating plugs**—*assure uniform flow, greater accuracy.*
- **Constant total capacity**—*regardless of inner valve position.*
- **No slamming or water hammer**—*valve seats against the flow.*

The valves are furnished for either proportional or two-position control in sizes from 2½" to 6" and in 125 and 250 lb. standard construction.

Mail the coupon today for complete details on these efficient new valves. Or, better still, talk to a nearby Johnson engineer. The specialist Johnson organization offers the most complete line of pneumatic equipment for solving all temperature, humidity and pressure control problems.

JOHNSON SERVICE COMPANY
507-S East Michigan St., Milwaukee 1, Wisconsin

Please send me Bulletin Nos. V-210 and V-211 describing your new Three-Way By-Pass Valves.

Name & Title_____

Firm_____

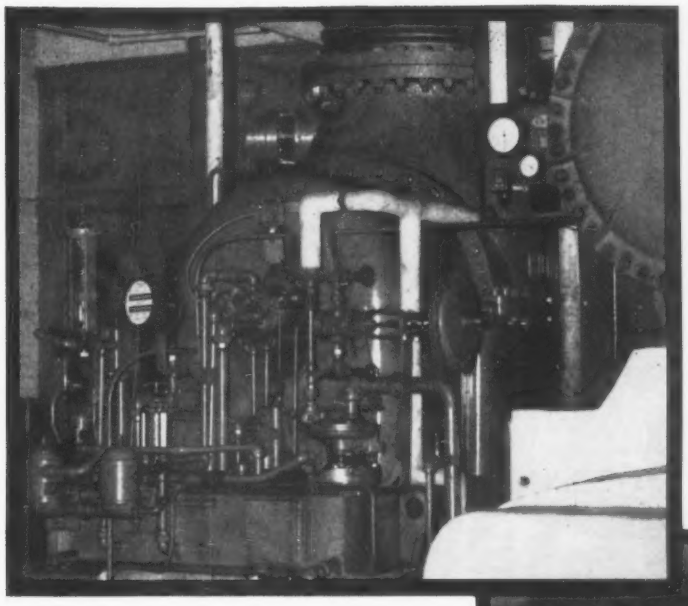
Address_____

City & State_____

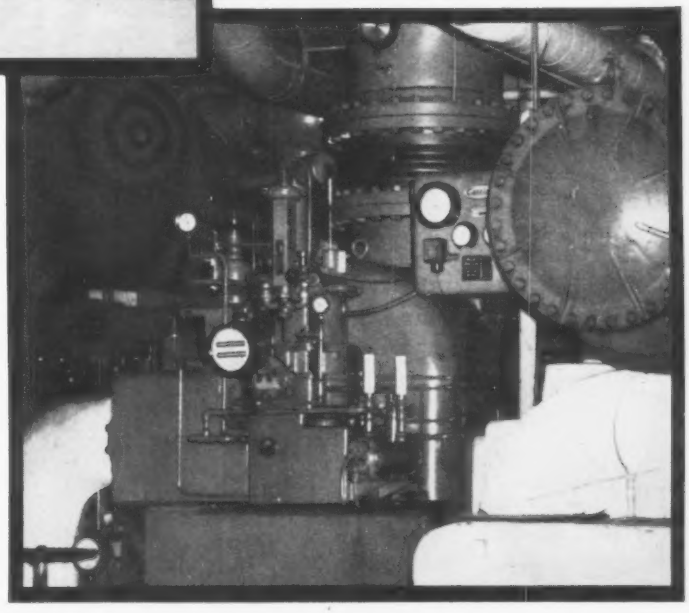
JOHNSON CONTROL

PNEUMATIC SYSTEMS

DESIGN • MANUFACTURE • INSTALLATION • SINCE 1885



1948—For air conditioning drive B. Altman & Co. installed a Murray low pressure turbine providing 633 HP at 5010 RPM.



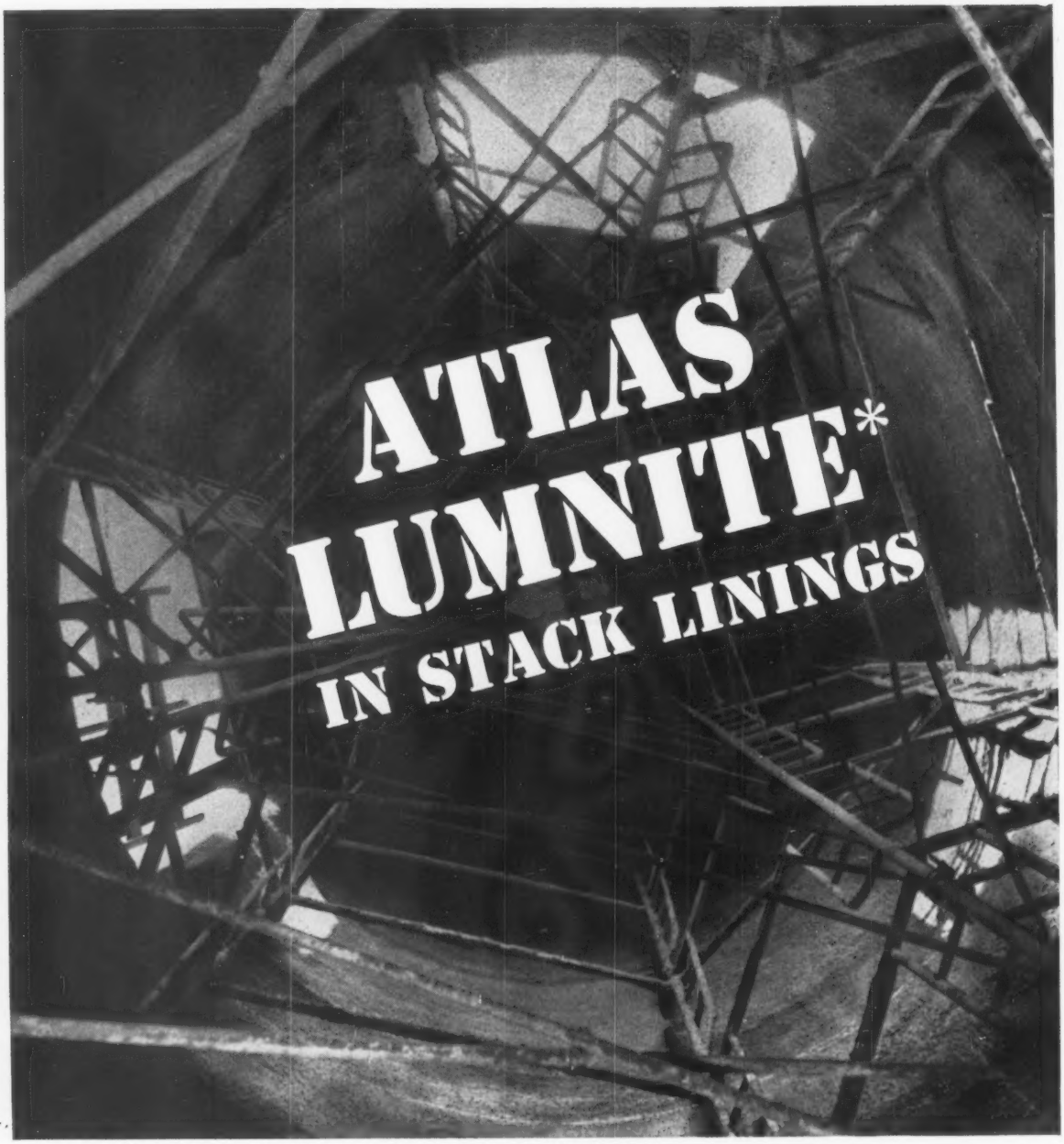
1950—Again B. Altman & Co. selected Murray to drive another air conditioning unit with a 905 HP, 3880 RPM low pressure turbine.

ALTMAN'S SCAVENGES LOW PRESSURE STEAM FOR AIR CONDITIONING DRIVE

B. Altman & Co. in New York City are utilizing low pressure steam to power the air conditioning of their large department store at 34th Street and Fifth Avenue. Economical Murray turbines operating on exhaust steam at only 2# gauge pressure provide the smooth dependable power for the store's two centrifugal compressors. Your low pressure steam can be utilized just as effectively to drive any type of machine. Murray's low pressure turbines are developing as much as 2200 HP in a single turbine and of course Murray's long experience assures you of an added plus value of service and long life.

Consult your local Murray representative who will be pleased to show you ways of utilizing your low pressure steam. MURRAY IRON WORKS COMPANY, Burlington, Iowa.

★★ **Murray Turbines** ★★



Looking up a 200-ft. power-plant stack being lined with corrosion-resistant concrete made with LUMNITE cement. One of two stacks (Units 4 and 5) of Pacific Gas & Electric Company's Contra Costa Power Plant near Antioch, Calif. Gunite Contractor: Johnson Western Gunite Co., Gardena, Calif.

- Industrial concretes, made with LUMNITE calcium-aluminate cement and suitable aggregates, resist heat, corrosion, abrasion, thermal shock – and provide insulation.
- Placement is fast and easy – by guniting, pouring or plastering.
- Downtime is reduced to a minimum because concretes made with LUMNITE cement are ready for service in 24 hours.

For maximum convenience, use castables made with LUMNITE cement. These are packaged mixtures, ready for use. Just add water, mix and place. Made and distributed by leading manufacturers of refractories.

Write for a copy of the "Lumnite Mortar Manual," describing gun-applied linings: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

*"LUMNITE" *is the registered trade-mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company*

L-168

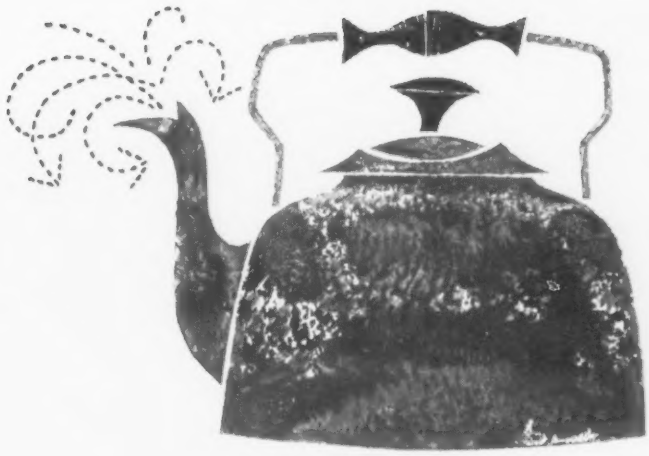
UNIVERSAL ATLAS CEMENTS

USS

TRADE MARK

UNIVERSAL ATLAS CEMENT COMPANY–member of the industrial family that serves the nation–**UNITED STATES STEEL**

OFFICES: *Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St. Louis · Waco*



LET'S TALK STEAM...

Below is a Vibra-Grate Stoker at work! . . . helping produce steam at lowest possible cost per pound. Look how evenly fuel is distributed in the bed — no holes, no light spots to cut down combustion efficiency!

Vibra-Grate feeds and moves wet or dry fuel automatically by intermittent vibrating motion. It is water-cooled to give you longer grate life and minimum maintenance.

You will also find that the AE Vibra-Grate Stoker gives you freedom from smoke at both high and low ratings . . . eliminates need for dust collectors and cinder return systems . . . will burn low-grade coals efficiently . . . continuously and automatically discharges ash . . . can burn gas or oil singly, or in combination with coal.

Vibra-Grate is built for efficiency. It is many years ahead of all others in design and performance. If you are modernizing or considering a new power plant, it will pay you to find out more about Vibra-Grate. Just write to American Engineering Company.

OTHER OUTSTANDING AE-DESIGNED STOKERS

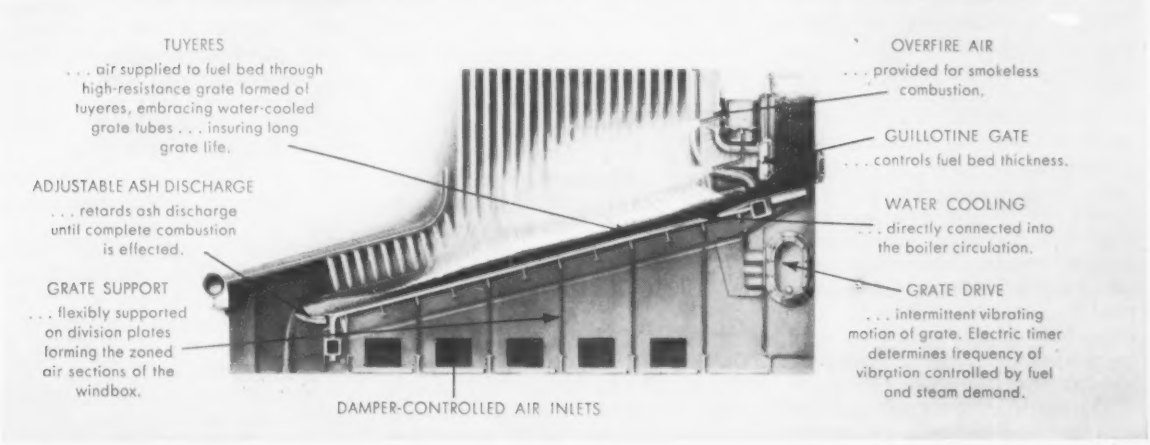
Perfect Spread Stoker: gives maximum combustion efficiency at lowest cost per pound of steam, REGARDLESS OF QUANTITY OF FUEL USED! Feeders have spiral-type rotors for lateral and longitudinal coal distribution.

Taylor Stoker, Type "H": low-cost steam for moderate-sized plants. The same underfeed principle of combustion in high-capacity stokers for large central stations and industrial plants.

Taylor Stoker, Type "R": for power requirements ranging from 20,000 to 500,000 pounds of steam per hour. A completely self-contained unit . . . quick-firing . . . with adequate reserve capacity.

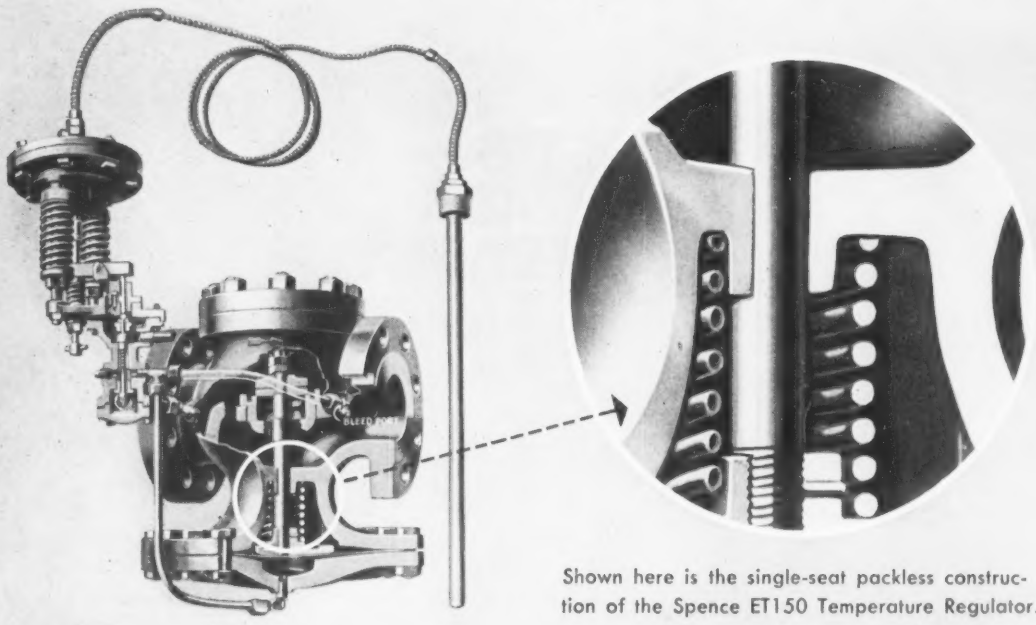
AMERICAN ENGINEERING COMPANY
Wheatsheaf Lane & Sepviva Street, Philadelphia 37, Penna.

Canadian Subsidiaries: Affiliated Engineering Corporations, Ltd., Montreal, P. Q. Bawden Industries Ltd., Toronto, Ont. S-100


TUYERES
. . . air supplied to fuel bed through high-resistance grate formed of tuyeres, embracing water-cooled grate tubes . . . insuring long grate life.
ADJUSTABLE ASH DISCHARGE
. . . retards ash discharge until complete combustion is effected.
GRATE SUPPORT
. . . flexibly supported on division plates forming the zoned air sections of the windbox.
DAMPER-CONTROLLED AIR INLETS
OVERFIRE AIR
. . . provided for smokeless combustion.
GUILLOTINE GATE
. . . controls fuel bed thickness.
WATER COOLING
. . . directly connected into the boiler circulation.
GRATE DRIVE
. . . intermittent vibrating motion of grate. Electric timer determines frequency of vibration controlled by fuel and steam demand.

VALVE TIPS:

Advantages of Packless Construction in Temperature Regulating Valves



Shown here is the single-seat packless construction of the Spence ET150 Temperature Regulator.

One of the biggest headaches in regulating valve maintenance is repacking stuffing boxes.

How often a valve needs repacking, how much time it takes, and the cost of the system downtime all vary with the construction of the regulator and the service it's used for. No matter how you calculate all these variables it's still a headache—and an expensive one.

In the temperature regulator shown above (Spence Type ET150) stuffing boxes are eliminated. This is done by what is known as "balanced" diaphragm construction. You can see in the cutaway drawing that pressure is applied to both sides of the large metal diaphragm. The upper side is exposed to delivery steam pressure and the lower side is exposed to loading pressure applied by the pilot. When the pilot closes, both delivery pressure and loading pressure are equalized through the bleedport and connecting tubing.

This construction not only does away with repacking problems, but it makes possible additional savings as well. For example, you will note in the sectional blow-up that this design eliminates a closely fitted stem and guide. Dirt or other foreign matter doesn't have much of a chance to lodge between these parts and cause sticking.

Another cause of binding or sticking, uneven expansion of closely fitted parts, is also eliminated with this design. In addition, valve stem wear is reduced for the same reason.

Lower maintenance is not the only advantage of this packless construction. Accuracy of regulation is also improved because friction due to a stuffing box, dirt, or uneven expansion is not a problem. The large, balanced metal diaphragm is more sensitive to slight changes in pressure.

Guaranteed Not To Wiredraw

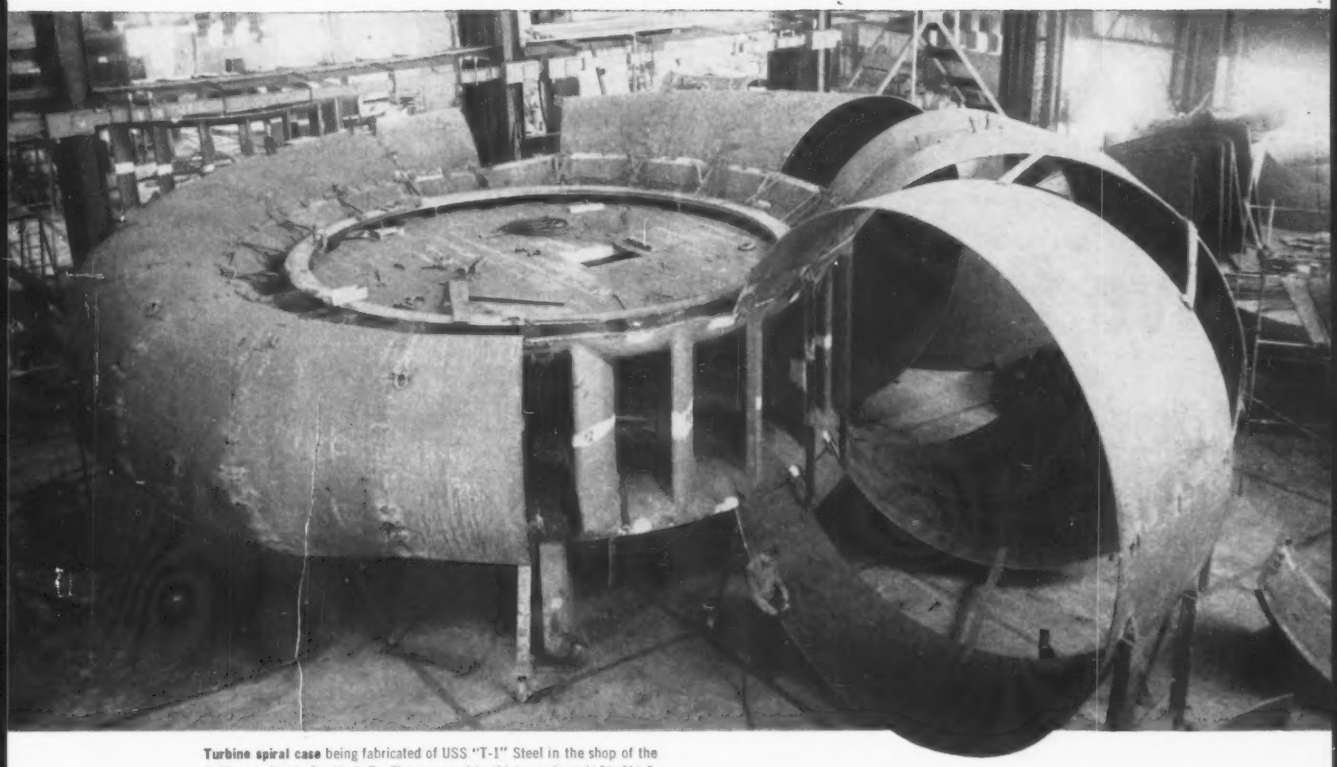
If seats and discs are cut by steam (wiredrawn) the loss of steam through these grooves can be another expensive item — directly charged against the regulating valve. Fortunately, you can eliminate these costly leaks by specifying a temperature regulator that is *guaranteed not to wiredraw*.

Spence makes such a guarantee because their seats and discs are made of SECO Metal. Over 20 years experience with this special alloy has failed to produce a single case where a SECO Metal seat or disc had been cut by steam. All that's required is an approved strainer located ahead of the regulating valve. Expensive steam leaks just can't happen with this combination of SECO Metal and single-seat design.

If you would like to have more information on Spence Temperature Regulators, drop us a line and ask for Bulletin T150. It gives more detailed information on these and other Spence design features. Piping layouts and helpful information on the installation of temperature regulators are also included. Write for your copy today.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SE 140



Turbine spiral case being fabricated of USS "T-1" Steel in the shop of the S. Morgan Smith Co., York, Pa. Plates ranged in thickness from ½" to 1 5/16".

Taming the mighty Snake River with turbine spiral cases of USS "T-1" Steel

Stronger steel reduces weight . . . cuts costs

Four of these huge spiral cases are being built for the Idaho Power Commission for use in the Brownlee Dam on the Snake River near Robinette, Oregon. They are designed for a 250-foot head of water. The inlet is 18 feet in diameter and each turbine will generate 144,000 horsepower at a speed of 128.6 rpm. Water will flow through the cases at a rate of 5,640 cubic feet per second.

Because of the fierce pressure, it was obvious that a strong steel was required. USS "T-1"* Steel was selected because it has a minimum yield strength of 90,000 psi. What's more, it can be fabricated, is readily weldable and has high resistance to impact abrasion.

Cost savings. By using USS "T-1" Steel, there will be substantially less shipping weight across the country and less weld time and weld metal, both in the shop and on the job site. Had carbon steel been specified, double thicknesses would have been required.

Fabricating operations. Projection of the dimensional outline on the plates was done with Lumitrace. Plates were cut to size by flame-cutting and rolled cold to shape. Some parts were finish welded, others were tack welded and assembled. The spiral case was then disassembled and shipped. Finish welding of segments is to be done at the dam site.

This job points up the economies possible with the use of USS "T-1" Steel. Why not use it for your own equipment? Write for our "T-1" book containing complete information. United States Steel Corporation, Room 2801, 525 William Penn Place, Pittsburgh 30, Pa.

Remember that we also make USS COR-TEN*, USS TRI-TEN* and USS MAN-TEN* Steels . . . widely used in power generation equipment.

*Registered trademarks

USS United States Steel

Here's Why...

Silicone Insulated Drive Motors Give Reliability At Lowest Cost

When reliability is a must . . . when essential auxiliaries have to keep going twenty-four hours a day, year in and year out despite temporary overloads and high ambients . . . that's when it pays to have drive motors that are insulated with heat-stable Dow Corning Silicones.

Utility engineers report that silicone insulated auxiliary drive motors carry 30% to 50% overloads without "strain or pain". That's because the thermal stability of Dow Corning Silicones means greater service factor than is possible with any other insulation.

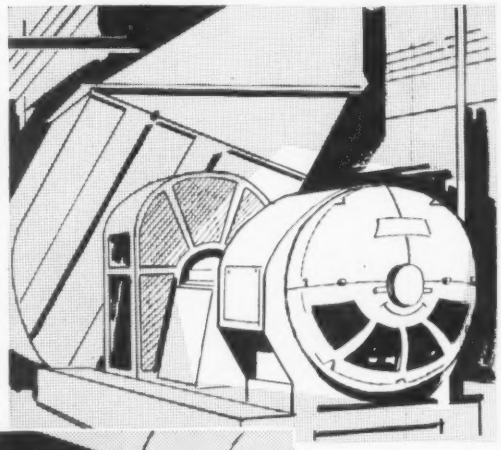
And silicone insulated motors operate at lowest cost because motor horsepower can be matched to normal load. When operating at full load efficiency, there's still plenty of reserve for overloads. You save money on power costs and maintenance, too.

What's more, silicone-insulated motors survive other power plant hazards, such as water, steam, dust, fly ash, cinders and similar motor-killing contaminants.

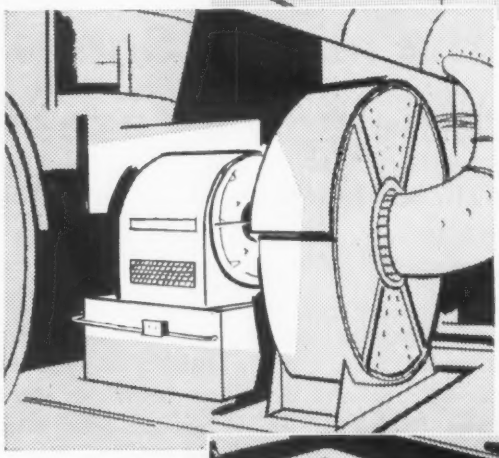
Most leading manufacturers now offer silicone-insulated motors in a wide range of sizes for power plant service. **Reliability costs less with silicones.** That's why it always pays to . . .

Specify DOW CORNING SILICONES and *Save*

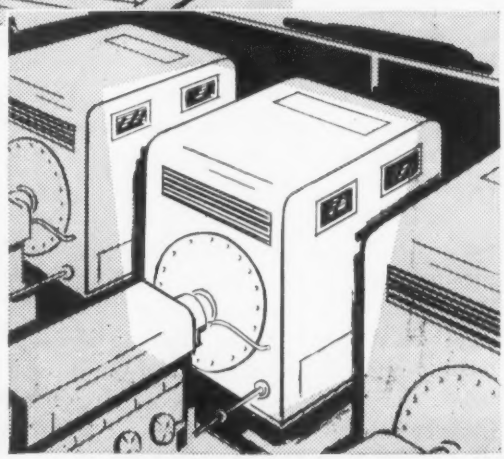
Write Dept. 693 for list of builders who offer Dow Corning silicone-insulated motors.



High ambients and temporary overloads are taken in stride by silicone insulated induced draft fan motors



Coal pulverizers and other essential auxiliaries operate more efficiently with silicone insulated motors matched to normal load



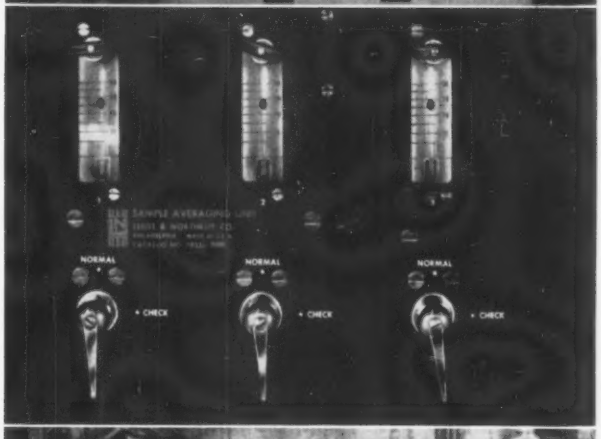
Self-protecting silicone rubber insulation in these boiler feed pump motors defies heat and moisture

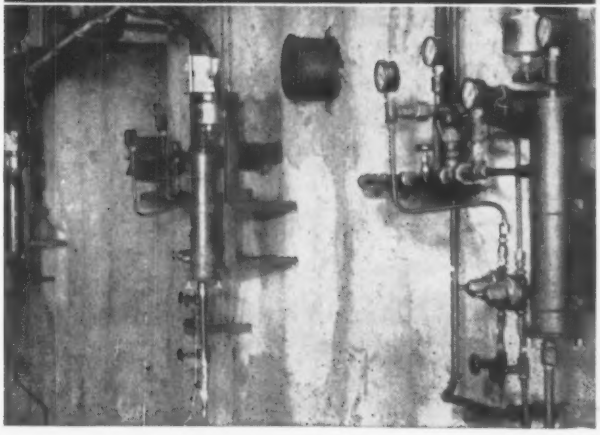
first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

ATLANTA • BOSTON • CHICAGO • CLEVELAND • DALLAS
DETROIT • LOS ANGELES • NEW YORK • WASHINGTON, D. C.





THE NEW SPEEDOMAX O_2 SYSTEM GIVES A CONTINUOUSLY ACCURATE COMBUSTION PICTURE...

Here's why!

■ Already, on some of the country's largest boilers, this new Speedomax O_2 System is enabling operators to trim excess air automatically to maintain combustion efficiency . . . and to do it with a certainty never before possible.

Why? As one operator put it, "The System gives me a record that's meaningful. When I look at this O_2 chart I know what's *really* happening—and I know it right away."

Behind this operator's confidence is the new L&N Multiple-Probe Sample Averaging Unit which *assures a more representative sample.* This unit maintains a true average from two, three, or more probes—even if individual sample flows drop 60 per cent. And excess air distribution across the duct can be checked right at the Averaging Unit.

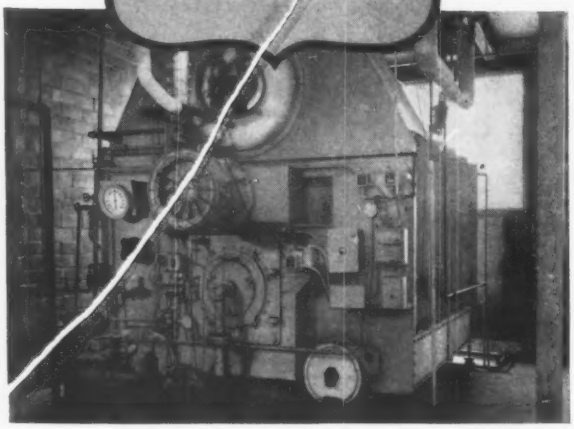
There is also a new Reverse Jet Probe and Steam Sampler which delivers a *clean pressurized sample* even with the *dirtiest* of flue gases. Water jets flush the probe passage continually, steam ejector action pressurizes the sample, and steam condensing action plus centrifugal separation remove all dirt and acid.

And, in analyzing and recording, the speed of response of the Speedomax Recorder, coupled with the efficient operation of the L&N Magnetic O_2 Analyzer, increases speed and accuracy of O_2 analysis and recording even further.

Why not learn more about this new Speedomax O_2 equipment and what it can do for you? Write to Leeds & Northrup Company, 4910 Stenton Ave., Philadelphia 44, Pa.

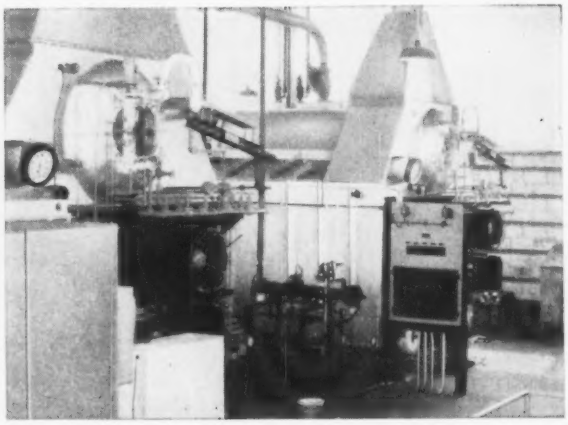
LEEDS & NORTHRUP
instruments • automatic controls • furnaces

four more economy-minded users capitalize on UNION PACKAGED BOILERS



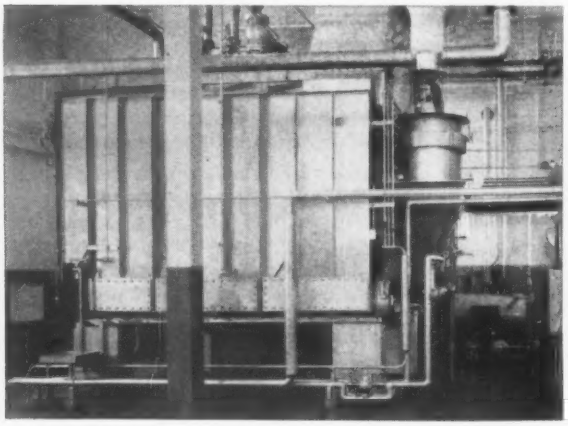
"NEEDED FLEXIBILITY" FOR EXPERIMENTAL CANNERY

The Green Giant Co., reputedly the world's largest packer of peas and corn, selected an 8,500 lb./hr. Union Packaged Boiler on the basis of "proven past performance of this type of unit." Installed to provide steam for its experimental processing plant, the MH Type Steam Generator provides "needed flexibility" to meet changing load demands of various process research projects.



THRIFTY PERFORMANCE LEADS TO CHOICE OF SECOND MH

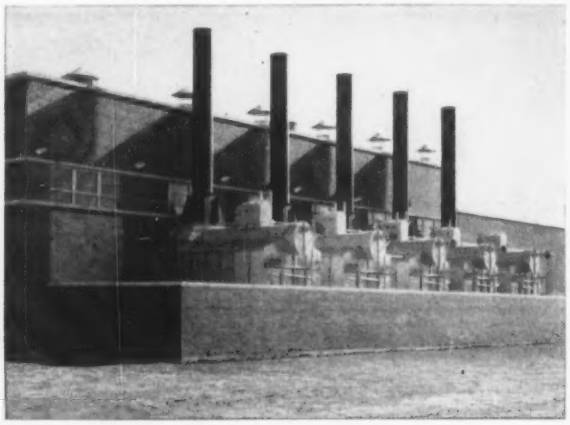
Following a policy of adopting "mechanical advances in machine design and automatic controls" to reduce costs, Mansfield Rubber Ltd. chose a 6,500 lb./hr. MH Boiler for its Ontario tire plant. "The performance and economy of this unit made the selection of a second quite simple," reports Mansfield. "We are particularly pleased with both boilers, especially when heavy steam is called for. They modulate well."



PICKED FOR SIMPLE, EASY INSTALLATION

H&D

Upon arrival, a new Union Packaged Boiler need only be positioned, connected up and lit off. In 1955, such simple installation was a big factor in the selection of this 20,000 lb./hr. unit for the new Hinde & Dauch plant at Eaton, Ohio. Delivering steam for space heat and processing, it plays an essential part in the manufacture of corrugated board for shipping boxes. This year, another MH (20,000 lb./hr.) was installed in H & D's Meriden, Conn. plant.



TWA BASE GETS STEAM THE MH WAY

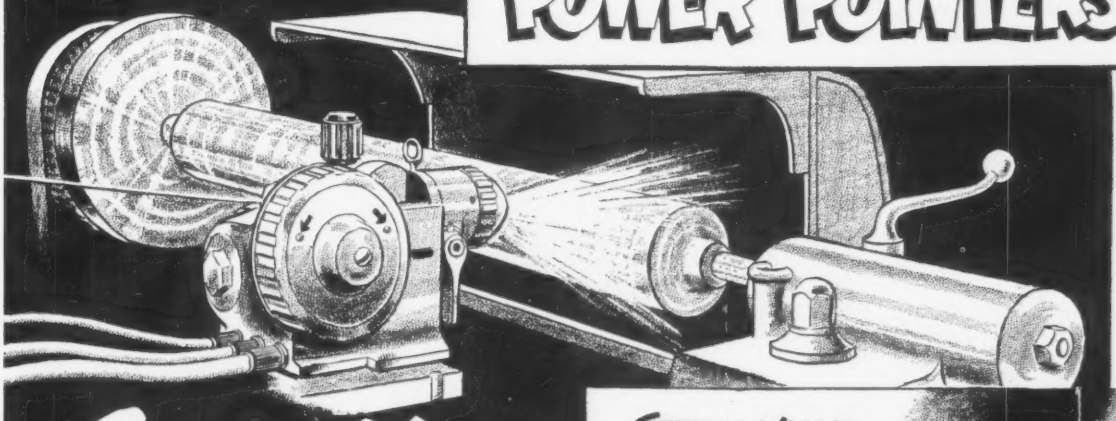
TWA

Selected jointly by TWA management, city contractors and city engineers, this "MH" quintette serves the enormous overhaul base at Mid-Continent Airport, Kansas City, Mo. Individually rated at 33,000 lbs./hr., Union's five-boiler team provides space heat for the cavernous hangar and other buildings, plus a power generating source for various cleaning, plating and pumping operations.

FOR USEFUL DATA on Union Type MH Steam Generators (Capacities: 10,000-60,000 lbs./hr.) request illustrated Bulletin MH-353.

UNION IRON WORKS
ERIE, PENNSYLVANIA

POWER POINTERS



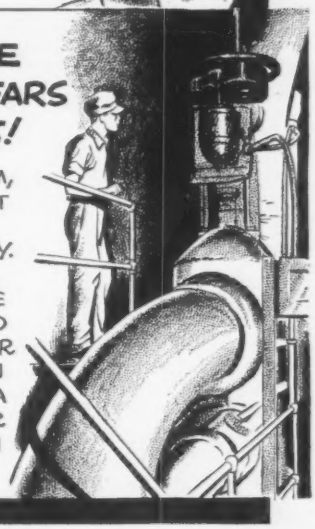
Sprays Monel

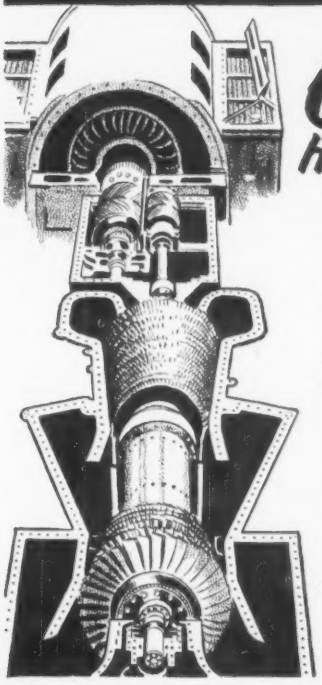
... stops rust-cutting of carbon seals

GLAND SECTIONS OF SHAFTS FOR SMALL MARINE STEAM TURBINES ARE NOW BEING SPRAYED WITH MONEL NICKEL-COPPER ALLOY FROM SPRAY GUNS THAT MELT AND BLAST DROPLETS OF METAL AGAINST THE SHAFTS. BY PREVENTING ROUGHENING OF THE SHAFT THE MONEL* ALLOY COATING HELPS MAINTAIN THE STEAM SEAL ...PREVENTS STEAM LEAKAGE AND RESULTING OIL CONTAMINATION.

STEAM VALVE SERVES 27 YEARS ...NO REPAIRS!

ITS SECRET: THE STEM, SEAT RINGS AND SEAT ARE MONEL NICKEL-COPPER ALLOY. MOTOR ACTUATED, THIS TROUBLE-FREE VALVE HAS RESISTED MORE THAN A QUARTER CENTURY OF EROSION AND CORROSION ON A MAIN STEAM HEADER OPERATED AT 350 PSI AND 700° F.

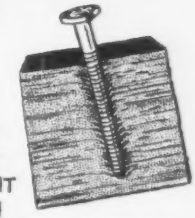




6,000 hours young

AFTER 6,000 HOURS' SERVICE, TURBINE BLADES, OPERATING AT RIFLE BULLET SPEED (1,200 FT/SEC.) AND AT RED HEAT (1,300-1,350° F. INLET TEMPERATURE) LOOKED AS THOUGH THEY HAD NOT BEEN USED AT ALL. FORGED FROM INCONEL* "X" AGE-HARDENABLE NICKEL-CHROMIUM ALLOY, THESE AND SIMILAR BLADES RESIST CREEP AND EXTREME OXIDIZING CONDITIONS MET IN INDUSTRIAL GAS TURBINES.

These nails are all "drive" and no backing out



ANNULAR GROOVES IN STRONG ANCHORFAST* MONEL NICKEL-COPPER ALLOY NAILS FORCE WOOD FIBERS TO SERVE AS WEDGES THAT LOCK INTO THE GROOVES AND PREVENT THE NAILS FROM BACKING OUT. IN COOLING TOWER SERVICE, THE GROOVES STAY SHARP AND EFFICIENT BECAUSE MONEL ALLOY RESISTS RUST AND CORROSION AND LOUVRES STAY PUT.

UP AGAINST A METAL PROBLEM?

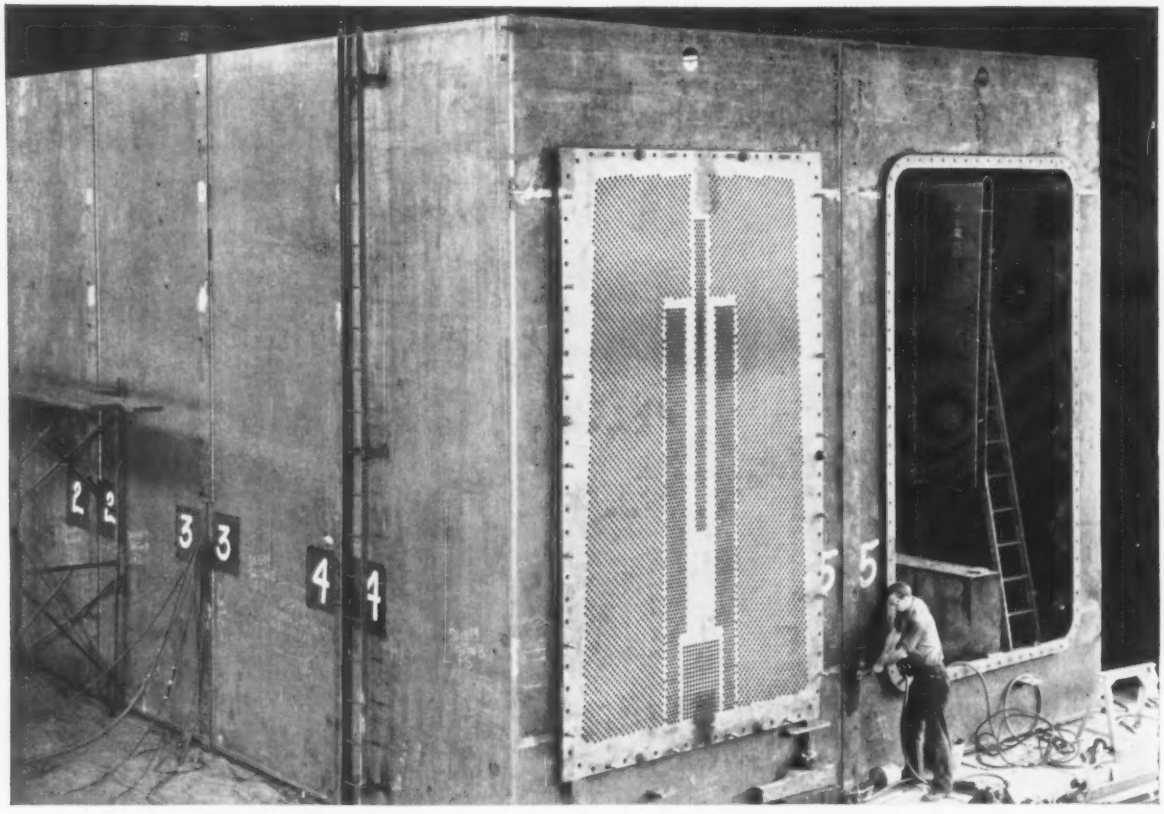
THERE'S A GOOD CHANCE THAT INCO'S MECHANICAL ENGINEERING SECTION HAS SOLVED A SIMILAR ONE OR COME CLOSE ENOUGH TO IT TO SUGGEST A GOOD ANSWER. JUST LET US KNOW THE DETAILS.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street — New York 5, N. Y.

INCO Nickel Alloys

*Registered trademark

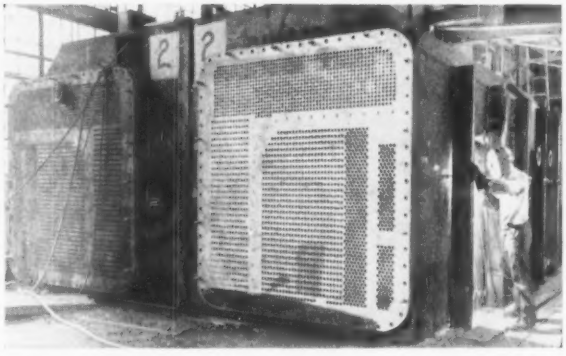


HERE'S ONE SHELL of this twin-shell, triple-lane unit just before shipment to Consolidated Edison's Astoria Station. It's designed to condense 1,600,000 lbs. steam/hr. at 1.87" Hg., with 244,000 gpm circulating water, and has 27,450 aluminum-brass tubes. Unit serves 335,000 kw turbine.

HUGE, SINGLE-PASS, 187,000 sq. ft. CONDENSER

. . . designed and built by C. H. Wheeler is now being installed at world's largest metropolitan utility

VICE-PRESIDENTS LEE YETTER and Roy Droescher, and Chief Engineer Paul Hamm are responsible for the design and construction of all Wheeler condensers. They work with engineers employed by C. H. Wheeler's customers, with turbine manufacturers' engineers and consulting engineers in BTU chasing.



TYPICAL REVERSE FLOW CONDENSER is this 35,000 sq. ft. unit for a Southern electric utility. Patented Reverse Flow feature permits flushing debris from tubes with only slight (and momentary) vacuum loss. Note low height to save head room, rectangular cross section to further utilize space for this Wheeler client.

C. H. Wheeler Mfg. Co.

19TH & LEHIGH AVENUE
PHILADELPHIA 32, PA.

Steam Condensers • Vacuum Equipment • Centrifugal, Axial & Mixed Flow Pumps • Marine Auxiliary Machinery • Nuclear Products

Unretouched photo of tube blister... the result of overheating

...AND THEN THE BLISTER BROKE

This blistered tube was the first sign of trouble in a high-pressure boiler. Accumulation of silica scale deposits on the water side interfered with heat transfer. Overheating caused blistering, subsequent tube failure and inevitable replacement. Proper water treatment can avoid this and other costly conditions such as sludge attachment, return-line corrosion and carry-over.

A Consulting Service for You. Whatever your problems—raw water supply...power plant data...cooling towers, ponds...types of fuel...equipment...test and control methods—Dearborn has the engineers, the experience and the facilities to assist you in developing the program exactly suited to your needs. Your Dearborn representative will outline the many advantages a Dearborn Consulting Service Program will give to you.

WHY NOT CALL HIM IN...
MEANWHILE SEND FOR THE NEW
DEARBORN CONSULTING SERVICE BOOKLET

Dearborn Chemical Company — Dept. PO-WT
Merchandise Mart Plaza, Chicago 54, Ill.

☐ Have a Dearborn Representative call
☐ Send your new booklet on Dearborn Consulting Service

Name.....
Title.....
Company.....
Address.....
City.....*Zone*.....*State*.....

Dearborn®

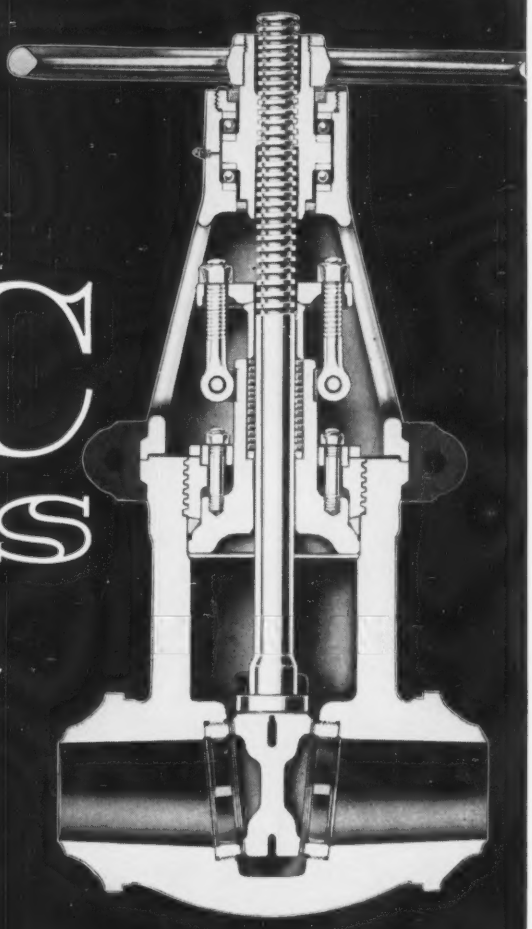
...the leader in water conditioning and corrosion control since 1887

Manufacturing plants in CHICAGO • LINDEN • LOS ANGELES • TORONTO • HONOLULU • HAVANA • BUENOS AIRES

ACCO
for Better
Values

R-P&C VALVES

THE COMPLETE LINE
—DESIGNED FOR DEPENDABILITY



R-P&C Pressure Sealed Valves Meet Requirements of High Pressure and High Temperature Applications

• The R-P&C Pressure Sealed Valve pictured above—made of electric furnace cast steel—has been successfully developed to meet demands for valves that provide tightness under varying conditions encountered at high pressures and high temperatures. These valves, available in gates (up to 12″) and globes (up to 8″) in 900, 1500 and 2500 pound classes, are also being used increasingly for less difficult services, because of the *inherent advantages of pressure-sealed construction.*

Among these advantages are: elimination of bonnet flanges; tightness unaffected by temperture changes; quick, easy inspection—disassembly and reassembly; reduced weight without loss of strength; savings of space; ease of insulation; neat appearance.

R-P&C Pressure Sealed Valves typify the high quality of the entire cast steel line, including gate, angle, globe, swing check and lift check styles in many sizes and pressure classes (150-2500 psi).

A COMPLETE Line of Valves

Whenever you need valves of *any* kind, it's good business to look to R-P&C. The R-P&C Valve line includes gate, globe, angle and check valves in bronze, electric iron and cast steel, and forged steel. Also, R-P&C offers a full line of cast steel fittings, as well as specialties such as bar stock and Lubrotite gate valves, asbestos-packed cocks and other items.

• • •

Write our Reading office for catalog.

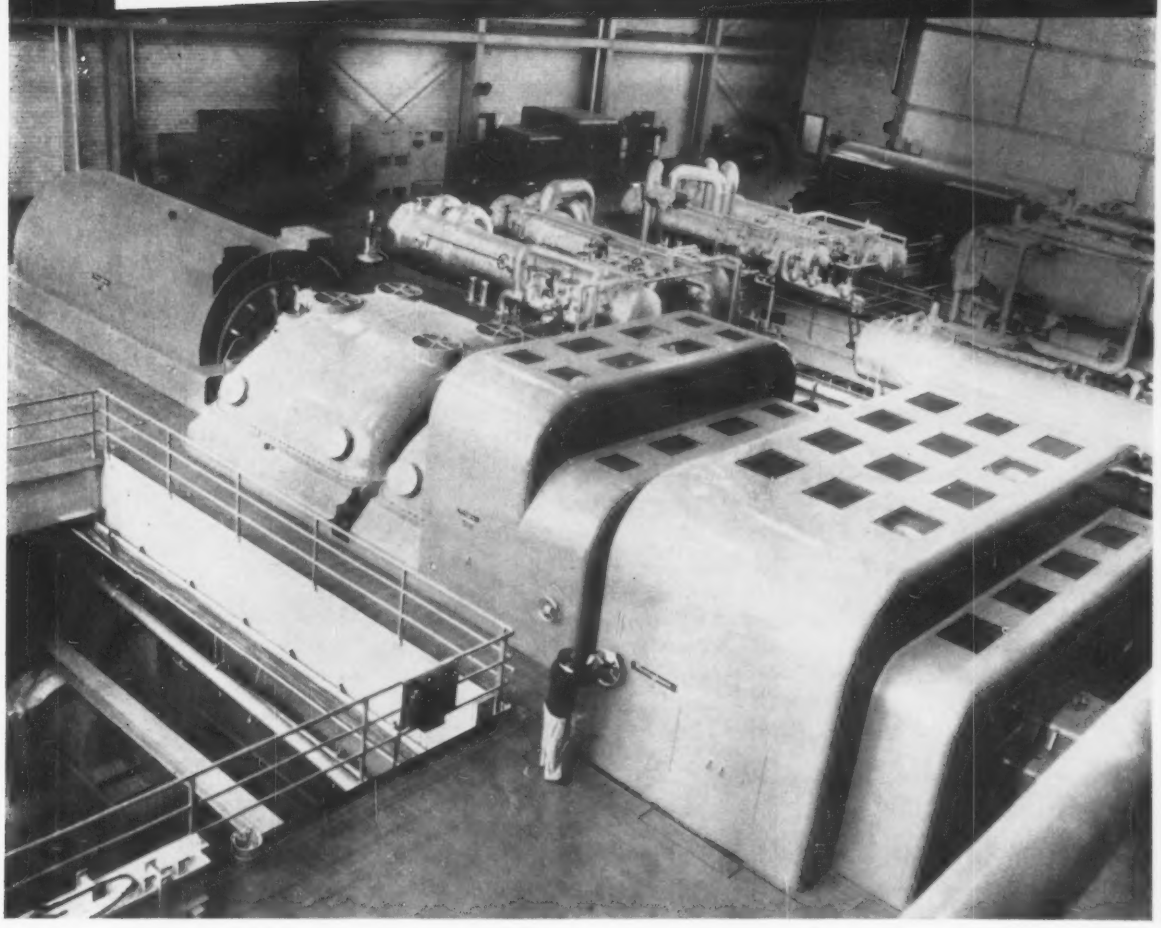
FREE WALL CHART
"How to Protect Your Valves"
Installation pointers, operating tips, clues to longer valve life. They are all on this 22″ x 17″ wall chart. Write for your free copy.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

ACCO

more POWER to you at Phoenixville



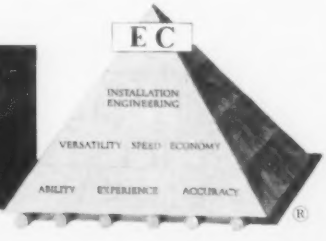
Eichleay **SERVICES**

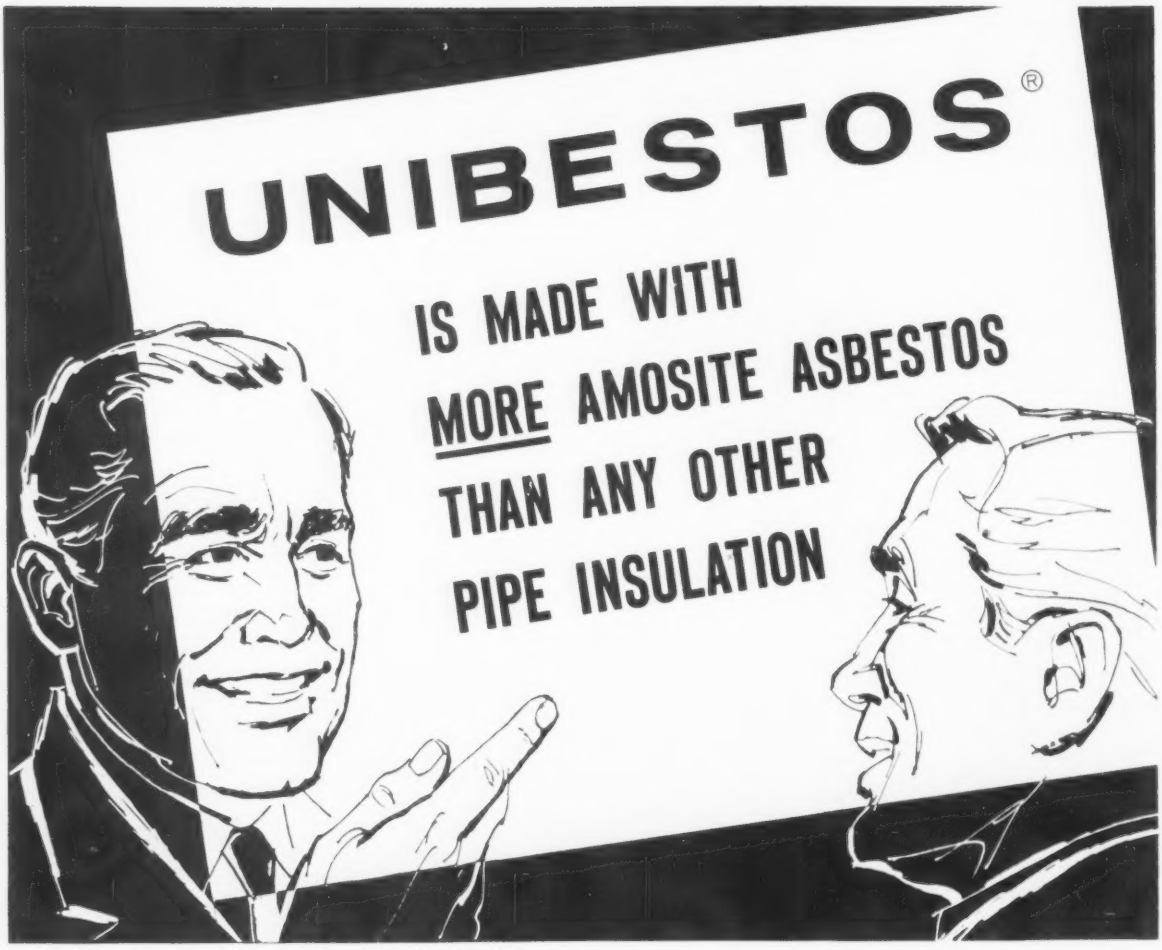
- Industrial Installations
- Construction of Heavy Foundations
- Building and Machinery Moving
- Shoring - Rigging

This 200,000 K W Westinghouse Turbine Generator was installed by Eichleay at the Cromby Power station of the Pennsylvania Electric Company near Phoenixville, Pennsylvania.
The unit is a three cylinder Tandem Compound Re-heat Type Impulse and Reaction Turbine driving a 200,000 K W Generator.

Eichleay
ESTABLISHED 1875

CORPORATION
33 South 19th St., Pittsburgh 3, Pa.
1180 Richard Ave., Santa Clara, Calif.
11919 Avenue O, Chicago 17, Ill.
Eichleay Corporation International, Canada





It's a *sure* way to save maintenance money!

Most insulations use merely a scattering of asbestos fibers to hold the mass together. So it's easy to see why UNIBESTOS is far stronger and so much *tougher*. Hammer blows can dent the surface, but never shatter or crack it. You can cut UNIBESTOS cleanly without breakage—walk on it. And, best of all, UNIBESTOS stands up like nothing else can with continued high thermal efficiency.

At competitive prices, rugged UNIBESTOS brings you the added advantages of easy installation, single-layer application, simplified fabrication for curves and fittings, unlimited re-usability, unmatched resistance to water and weather.* It's the favorite wherever used—the *standard* in modern power plants from coast to coast. We'll be glad to send you complete information on durable UNIBESTOS...the only pipe insulation made almost entirely of Amosite asbestos. Sizes to 44" o.d.

*An exposed and non-weatherproofed installation of single-layer UNIBESTOS, applied to 1500° pipe although its temperature limit normally is considered as 1200°, already has been removed for pipe inspection four times and re-installed as fully serviceable.

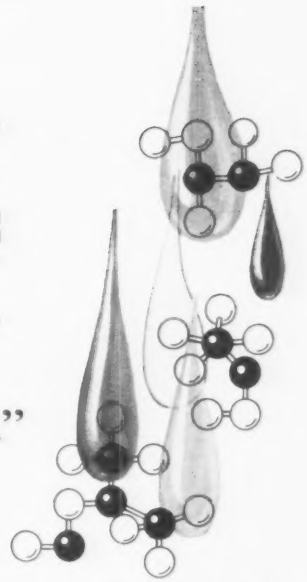
UNARCO®

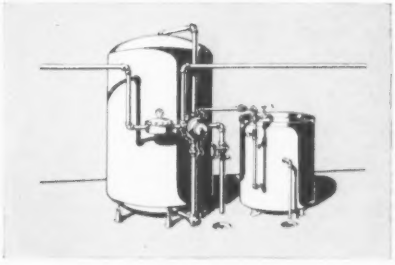
UNION ASBESTOS & RUBBER COMPANY
1111 W. Perry Street, Bloomington, Illinois

INSULATIONS • PACKING • GASKETING • ASBESTOS TEXTILES • INSULATING CEMENTS

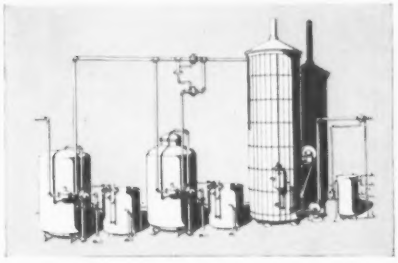
Quote and Unquote:—

"Elgin has dug deeper into ION EXCHANGE than any other firm"

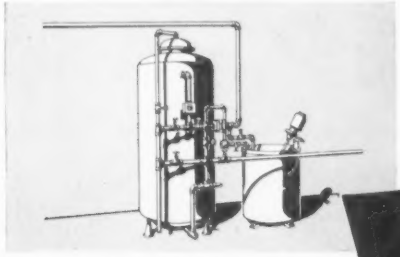




SOFTENING BY ION EXCHANGE — used to eliminate calcium and magnesium hardness from water. All types of ion exchangers available to meet specific conditions.



DEALKALIZATION BY ION EXCHANGE — produces soft water of controlled alkalinity. Various exchangers used, depending on requirements.



DEIONIZATION BY ION EXCHANGE — produces water of better than distilled quality. Ion exchangers of mixed-bed or multi-column design give "tailor-made" effluent to meet process or boiler plant requirements.

An engineer said this when he was asked why he had brought his not-too-simple water conditioning problem to the Elgin organization.

The particular way he put it set us to wondering how many men with water conditioning problems realize the great strides that have been made in ion exchange . . . how many recognize the vital importance of dealing with a firm that has played a leading role in ion exchange development and application.

It is always bad taste—often bad business—to boast; so we won't say that Elgin has dug deeper than *any* other organization. We simply say that certainly no firm has dug *deeper* into ion exchange application than has Elgin during nearly a half century of specialization.

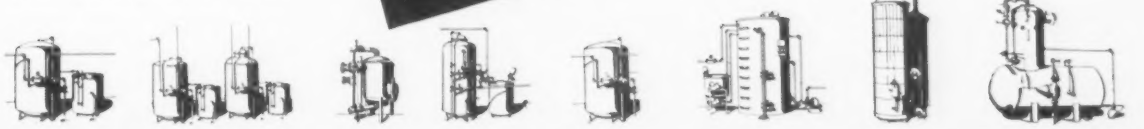
It is squarely on the record that across the years we have *been a part* of the transition from the first simple greensand through the highly specialized ion exchangers and methods that are today accomplishing little short of water conditioning miracles. Just three of almost countless examples of this are given at the left.

Yes, today it can be said that there is a way to "make over" *any* water supply—*your* water supply—to exactly the kind and quality needed for *any* use. When you put your problem up to Elgin you are certain that Elgin "deep digging" will not only assure you the *right* way, but, still more important, the most *economical* way.

Never forget that Elgin works with *all* methods. No bias; no single-track thinking. One of our engineers will be glad to study your conditions and give you a demonstration of Elgin deep digging.

ELGIN
WATER CONDITIONING
SINCE 1908

ELGIN SOFTENER CORPORATION
130 N. Grove Avenue, Elgin, Illinois
Representatives in Principal Cities
In Canada: G. F. Sterne & Son Ltd., Brantford



SOFTENERS | ION EXCHANGERS | FILTERS | DEIONIZERS | DEALKALIZERS | CLARIFIERS | DEGASITORS | DEAERATING HEATERS

need steam traps?

name the way you want them!

TYPE A

TYPE D

TYPE C

Nicholson can supply your steam traps, exactly as you want them . . . for any service, any condition. Name the size, material, pressure, capacity you need. Types A, D, C are the ones you'll most likely use. Make your selection.

Sizes: A—from $\frac{1}{4}$″ to 1″. D—from $\frac{1}{4}$″ to $\frac{3}{4}$″. C—from $\frac{1}{2}$″ to 2″.

Materials: Cast Iron, Cast Steel and Bronze.

Pressures: A and D—Vacuum to 200 lbs. C—Vacuum to 300 lbs.

Capacities: From two to six times greater orifice area and capacity than other traps of comparable size.

Why wonder about your steam traps . . . when you can get Nicholsons exactly as you need them for your own applications. Nicholson traps are simple in design, have only one moving part . . . a valve that discharges condensate and prevents steam loss.

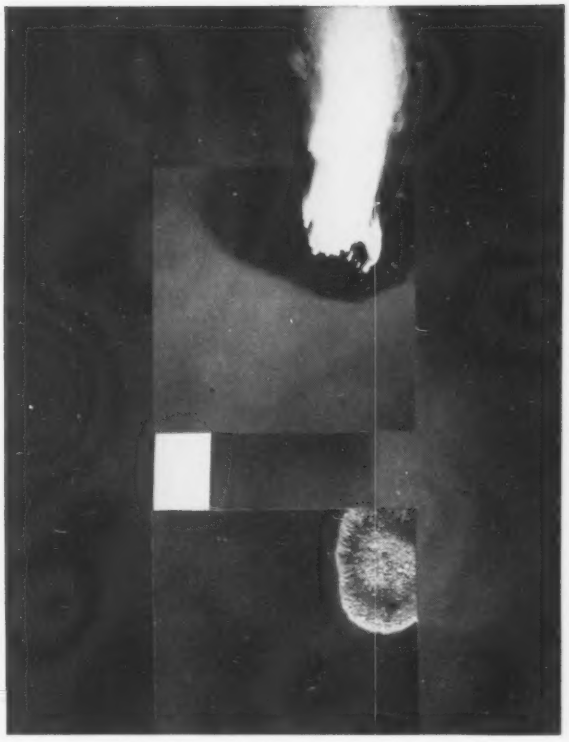
You get faster warmup, with high air-venting capacity. You eliminate costly leakage, with a powerful shut-tight valve action. You get a trap that's service-tested, when you specify Nicholson. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and engineering offices in 98 principal cities.

NICHOLSON

of Wilkes-Barre

METAL-CLAD SWITCHGEAR

TORCHES IGNITE FLAMETRAP (bottom) and conventional insulation (top) simultaneously.



SECONDS LATER, FLAMETRAP has snuffed out, but conventional insulation still burns briskly.

New FLAMETRAP Insulation Snuffs Out Flame ...No Toxic Gases...Highest Arc Resistance

FLAMETRAP INTERPHASE BARRIER. Standard equipment on I-T-E 5 and 15 kv switchgear at no increase in price.

Take the heat away, and this new I-T-E developed FLAMETRAP insulation snuffs out . . . fast! This is today's most advanced flame-retardant insulation, and it is used exclusively in I-T-E Switchgear.

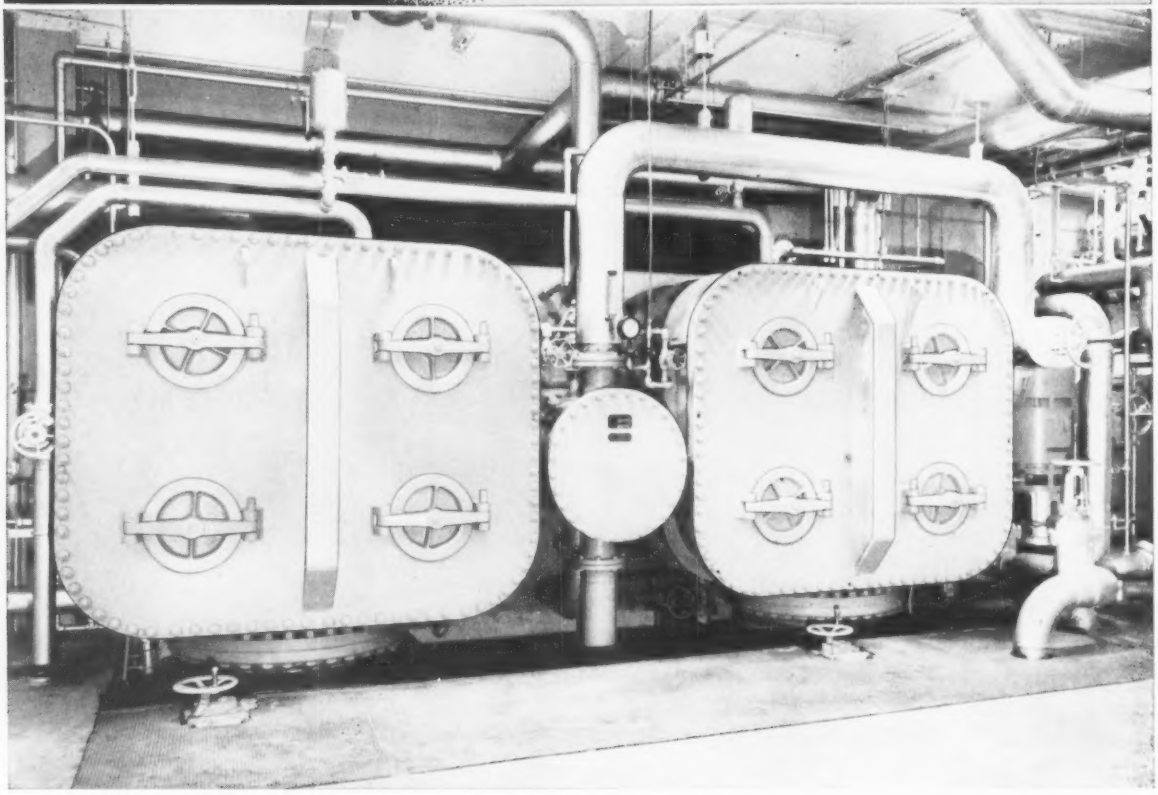
FLAMETRAP contains melamine resin—heretofore considered too expensive for commercial application. Unlike substitute ingredients, melamine gives off no toxic gases when it burns. So FLAMETRAP is far safer. And melamine stands up better under high temperatures. So FLAMETRAP suffers less from arc damage.

This latest improvement puts I-T-E switchgear even further ahead of the pack. It is one more of the quality details that keep coming your way from I-T-E without increase in price.

I-T-E service is as near as your telephone or mailbox. Why not call or write today. I-T-E Circuit Breaker Company, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa. In Canada, Eastern Power Devices Ltd., Port Credit, Ont.

I-T-E CIRCUIT BREAKER COMPANY
PHILADELPHIA, PENNSYLVANIA

PROGRESS IN POWER through PROGRESS IN HEAT TRANSFER EQUIPMENT



NEW-DESIGN CONDENSERS SAVE SPACE AND MONEY

Steam generation of electricity has made tremendous progress in the last 25 years because of the ever-increasing efficiency of the equipment used.

A power equipment manufacturer with many "firsts" to its credit, Yuba is continually designing, among other equipment, condensers with low head room to save much-needed space. This advancement is illustrated above in the photograph of a rectangular shape condenser for the Suwanee River Plant of the Florida Power Corp.

A low pressure heater is installed between the tube banks to further save plant space, as well as initial cost for foundation and piping. An additional design feature of Yuba condensers is a de-aerating section within the condenser shell which eliminates the main plant de-aerating heater. Maintenance and downtime costs are reduced by welding tubes into tube sheets.

For advanced condenser design, that will save space and money, consult the Yuba Heat Transfer Division, formerly the Heat Exchanger Division of The Lummus Co.

YUBA HEAT TRANSFER DIVISION

HONESDALE, PENNSYLVANIA
NEW YORK SALES OFFICE: 530 FIFTH AVENUE
REPRESENTATIVES IN PRINCIPAL CITIES

Other Yuba Divisions
Adsco Division, Buffalo, N. Y.
California Steel Products Division, Richmond, Calif.
Yuba Manufacturing Division, Benicia, Calif.

YUBA

STEAM SURFACE CONDENSERS
EVAPORATORS
STEAM JET REFRIGERATION
STEAM JET AIR EJECTORS
FEEDWATER HEATERS
BAROMETRIC CONDENSERS

YUBA CONSOLIDATED INDUSTRIES, INC.

to move an ocean–

by the bucketful is all right for this Sunday engineer, but for full time, 24-hour transfer of millions of gallons of water, rugged Peerless Hydro-Foil Pumps are the answer. Steam generation plants, sewage disposal plants, large irrigation and drainage projects, flood control stations and many other rigorous duties are being handled efficiently, dependably and economically by these giants of the pumping world. Available as either propeller type or mixed flow type, Peerless Hydro-Foil pumps have proved themselves to be the finest from every standpoint. For the big jobs, get the big pump, get the Peerless Hydro-Foil!

WRITE FOR ILLUSTRATED BULLETIN NO. B-148

PEERLESS PUMPS

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque. **Distributors in Principal Cities.** Consult your telephone directory.

Modernize your v-belt drives with

TAPER-LOCK SHEAVES

–proved in over a million installations!

- **No flange. No collar. *It's different.***
- **Easy on,—easy off.**
- **Just tighten the screws that wedge the bushing. Simple, isn't it?**
- **Always a perfect fit on shaft—tight as "shrunk-on."**
- **Complete range of sizes. A, B, C and D grooves, in *stock*.**
- **Try it—and you'll standardize on it!**

Taper-Lock Sheaves, with their precision machining, team up with matched Sealed-Life V-Belts to insure steady performance and unusually long belt life.

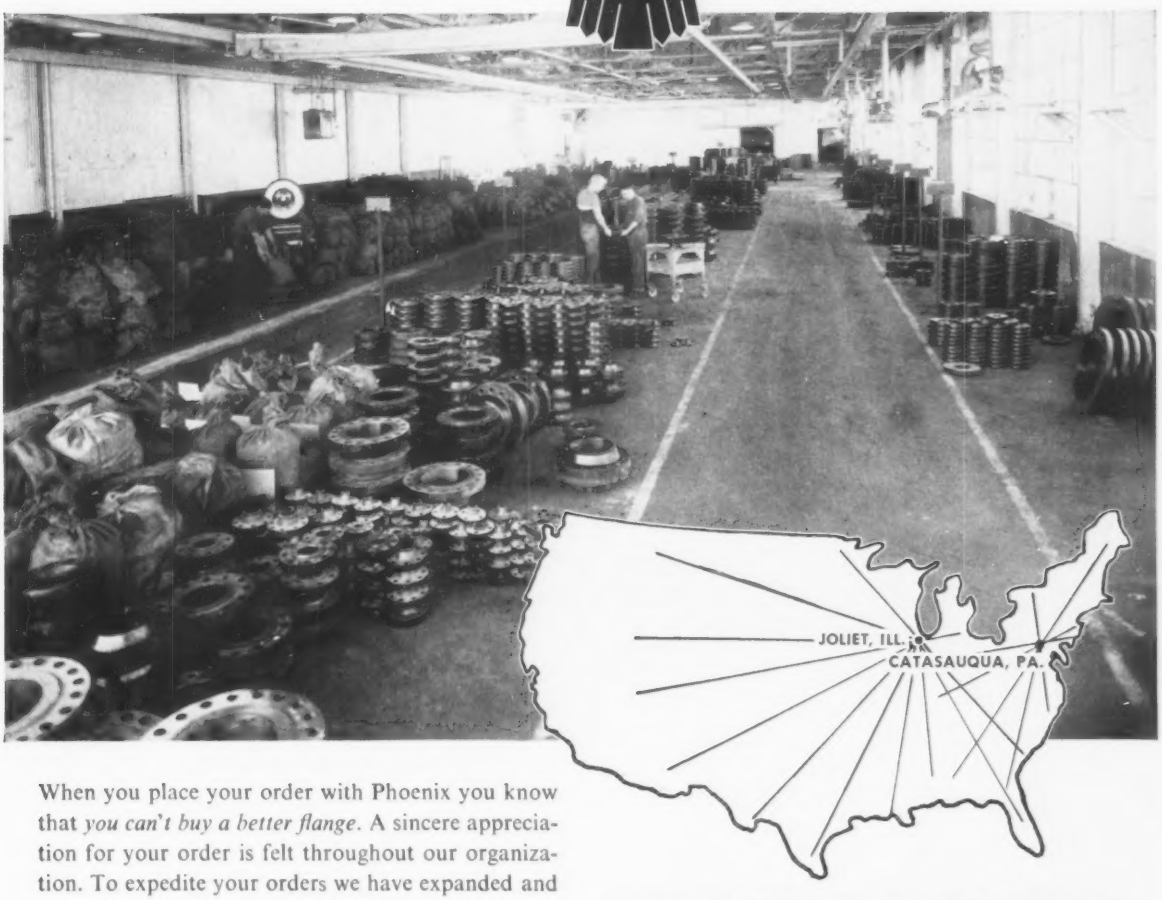
DODGE MANUFACTURING CORPORATION, 3200 Union St., Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer."

DODGE

of Mishawaka, Ind.

Why Service On PHOENIX FLANGES Is So Good!



When you place your order with Phoenix you know that *you can't buy a better flange*. A sincere appreciation for your order is felt throughout our organization. To expedite your orders we have expanded and streamlined our warehouse facilities, as shown, to make Phoenix service even better. For your regular requirements or special flanges in carbon or alloy steel, contact Phoenix and we'll show you what we mean.

Write for handy 36 page pocket-size reference booklet containing useful data on flanges.

IMMEDIATE SHIPMENT FROM TWO FACTORY WAREHOUSES

Conveniently located in the East near Philadelphia and Metropolitan New York and in the Midwest near Chicago, Phoenix factory warehouses at Catasauqua, Pa. and Joliet, Ill. are prepared to ship immediately regular types and sizes of quality Phoenix forged steel pipe flanges. That's why prompt delivery is assured—overnight to nearby points —in only a few days to distant points.

Leading Manufacturers of Pipe and Tank Flanges and Commercial Forgings

PHOENIX

FLANGE AND FORGING DIVISION

PHOENIX MANUFACTURING COMPANY

CATASAUQUA, PA. · JOLIET, ILL. · FOUNDED 1882

Integrated Manufacturing Facilities: FLANGE AND FORGING DIVISION, STEEL MILL DIVISION, HORSESHOE PRODUCTS DIVISION, RUBBER PRODUCTS DIVISION

You know you're safe with USS National Seamless Tubes

In a giant superheater like this, or in any tubular installation where pressures and temperatures are intense, where strength is critical, power engineers specify "National Seamless Steel Tubes." Reason: National Seamless gives longer, safer, more dependable, more economical service. And what more could any tubular product offer?

For further details, send for Bulletins 12 and 26. For technical assistance, don't hesitate to get in touch with us. Our mill service force is available for field consultation. Write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS and National are registered trademarks.

"The world's largest and most experienced manufacturer of tubular products—National Tube"

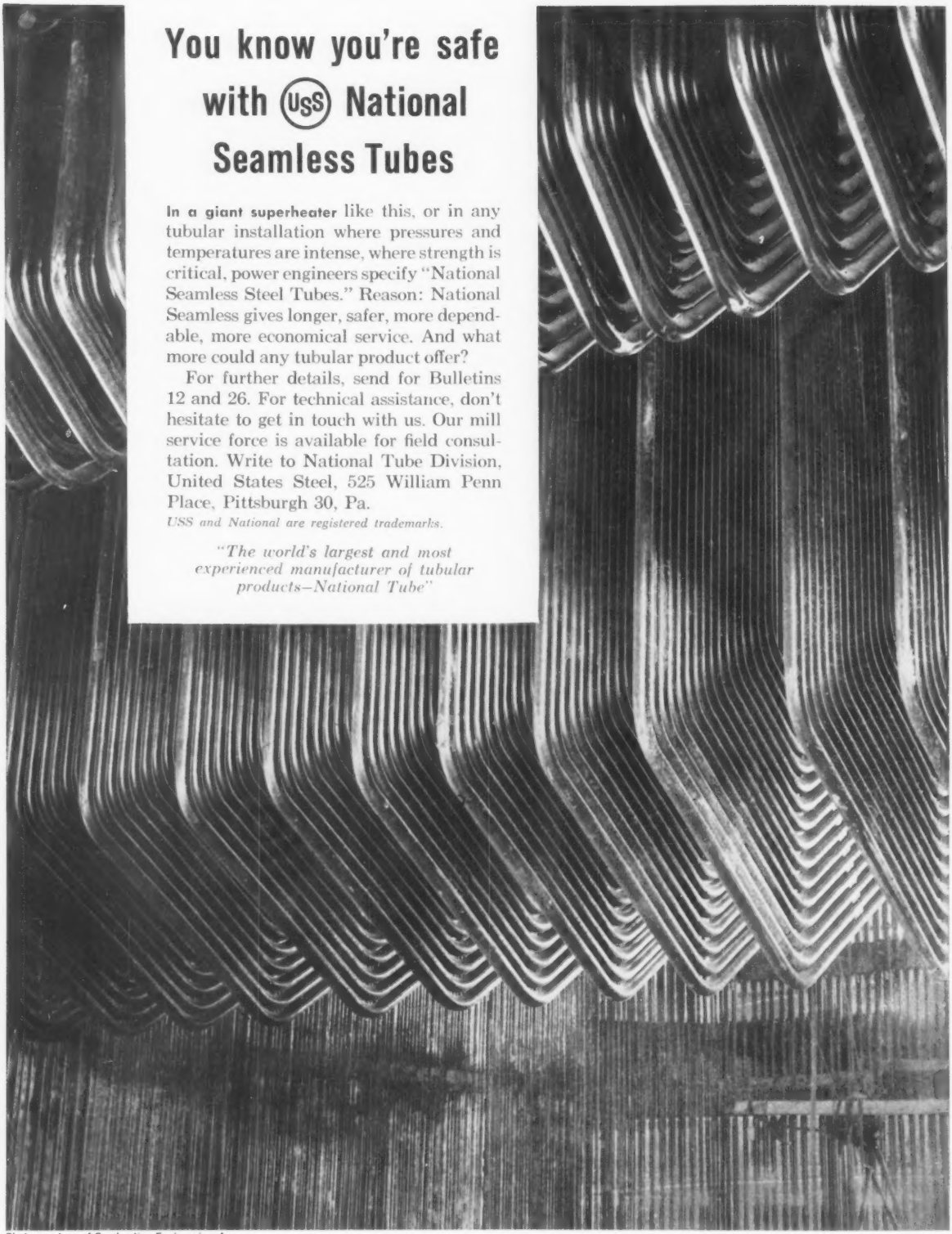


Photo courtesy of Combustion Engineering, Inc.

National Tube Division of USS United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • United States Steel Supply Division • United States Steel Export Company, New York

In its Lake Parker Plant, the City of Lakeland, Florida, utilizes 11 air compressors . . . for air-operated combustion control, for pneumatic tools, and to power soot blowers for cleaning boilers. These compressors are on duty day and night to supply dependable electric power to more than 60,000 customers.

TO PROTECT POWER GENERATING PLANTS:

Lakeland, Florida, guards against air compressor fires and explosions with fire-resistant Pydraul AC

Like all American cities, Lakeland progresses on constant and reliable electric power day in and day out.

To insure this dependable supply of electricity, Charles Larsen, Superintendent Light and Water Department, specifies fire-resistant Pydraul AC as the lubricant for all Lakeland power plant air compressors. As Mr. Larsen points out, "Pydraul AC gives more than excellent lubrication. It also protects us against fire and explosion dangers in our air compressors. You can't really measure that advantage and security." Pydraul AC will also minimize carbon deposits on exhaust valves and air piping systems . . . where fire danger really lurks!

Conversion is easy . . . essentially, just drain your flammable oils and replace with fire-resistant Pydraul AC.

Send in the coupon for your copy of the Pydraul AC booklet...it answers compressor lubricant questions.

Pydraul: Reg. U. S. Trademark

Organic Chemicals Division
MONSANTO CHEMICAL COMPANY
Dept. PO-2
St. Louis 24, Missouri

Monsanto®
Where Creative Chemistry Works Wonders for You

Please send me the Pydraul AC booklet.

Name ..... Title .....
Firm .....
Address .....
City ..... State .....

Six choices of corrosion resistant tubes and sockets

4130 alloy steel tube with alloy steel tip and socket.

403 stainless steel tube with alloy steel tip and socket.

403 stainless steel tube with 416 stainless tip and socket.

316 stainless steel tube with alloy steel tip and socket.

316 stainless steel tube with 303 stainless tip and socket.

Monel tube with alloy steel tip and socket.

Tubes and sockets listed above are available in Type 100 Mastergauges which are designed for extreme service and pressures. Type 101 Mastergauges, for medium and high pressures, are available with:

4130 alloy steel tube, with alloy steel tip and socket.

403 stainless steel tube, with 416 stainless steel tip and socket.

403 stainless steel tube with alloy steel tip and socket.

STAINLESS...from socket to tip

Another Marsh development! The superlative Mastergauge is now available with stainless and alloy steel bourdon tubes. Try to find a corrosive service that isn't covered by range of materials listed above.

Tube, socket and tip—every part subjected to a corrosive medium—are fused into one piece by the "Connoweld" process . . . the exclusive process that distinguishes the Marsh Mastergauge from all other gauges.

Whether you need a gauge for corrosive service or any other critical application, Mastergauge is the one correct answer. It gives you the leak-proof Connoweld construction, the stronger, more durable copper-clad Marshalloy case, the precision Mastergauge movement, the "Recalibrator" to preserve its unmatched accuracy. Ask for data covering your specific gauge needs.

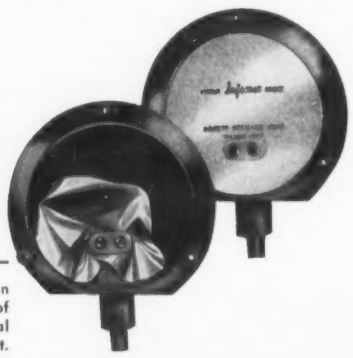
MARSH INSTRUMENT CO. Sales Affiliate of Jas. P. Marsh Corp. **Dept. F, Skokie, Ill.**
Marsh Instrument & Valve Co. (Canada) Ltd. 8407 103rd St., Edmonton, Alberta
Houston Branch Plant: 1121 Rothwell St., Sect. 15, Houston, Texas

MARSH GAUGES

"THE STANDARD OF ACCURACY"

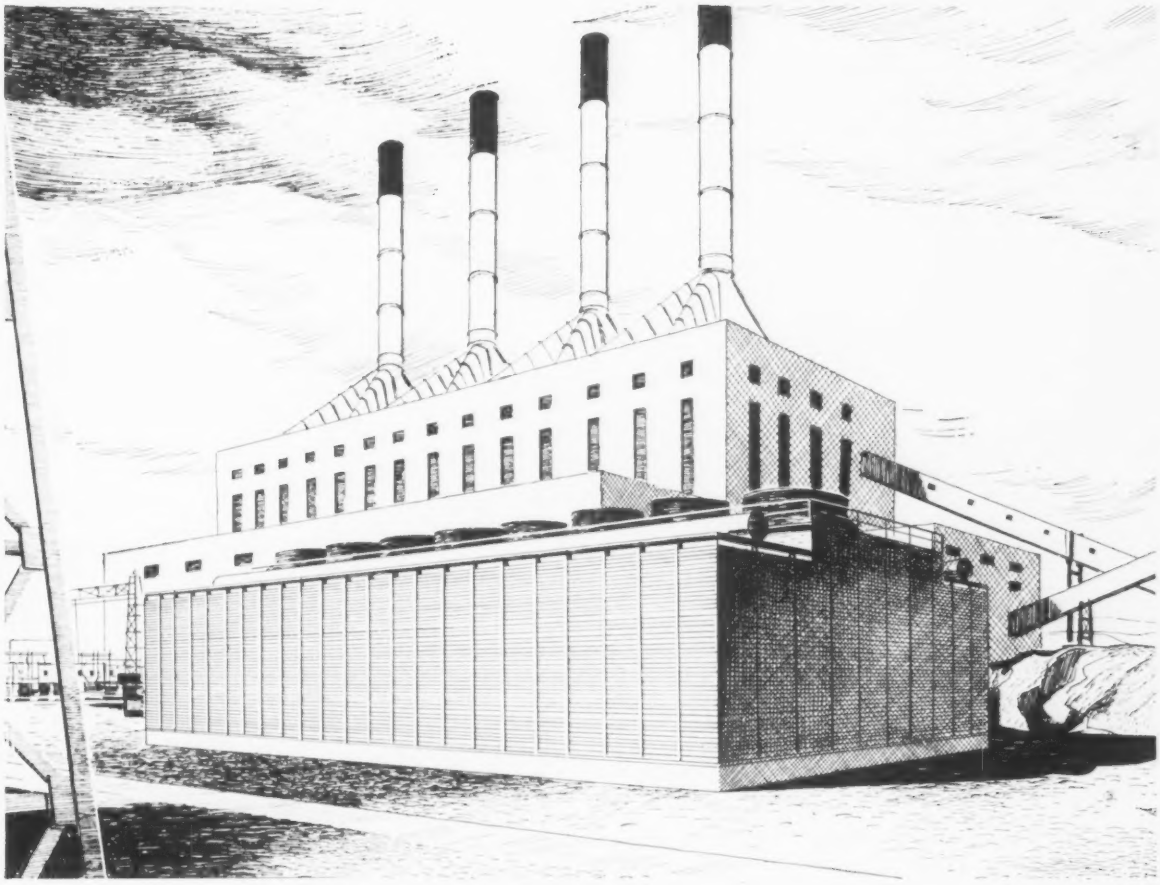
Stainless steel tube in the new SAFECASE

Here is a great combination . . . Marsh Mastergauge with corrosion resistant bourdon tube in the revolutionary Marsh Safecase . . . everything it takes for corrosive service where a surge of overpressure can occur.



Explosive force merely opens safety back—

Photo shows result of laboratory test in which gun cartridge was discharged in rear compartment of Safecase. Thin, tough back yields to abnormal pressure, but cannot be dislodged by blowout. Front of gauge remains intact, protected by heavy metal barrier.



CORROSION IS COSTLY

control it with CALGON®

Corrosion damage to cooling and service water systems is costly in more ways than one. When you count replacement costs of the system itself, and add to that the expense of delays and outages and even damage to high priced equipment, corrosion looms as a very large cost factor.

Systems *can* be protected against these needless costs. Calgon Engineering Service can provide the right answer to your particular problem. Water temperature and chemical makeup, the type of system, the metals exposed to water damage, these, and many other factors, determine the Calgon engineer's recommendations.

Calgon* is used to control destructive corrosion in tubing and heat exchangers, even at elevated temperatures. Provision is made for the control of organic growths and for the protection of cooling towers, as well. In each case, treatment is set up to protect the entire system.

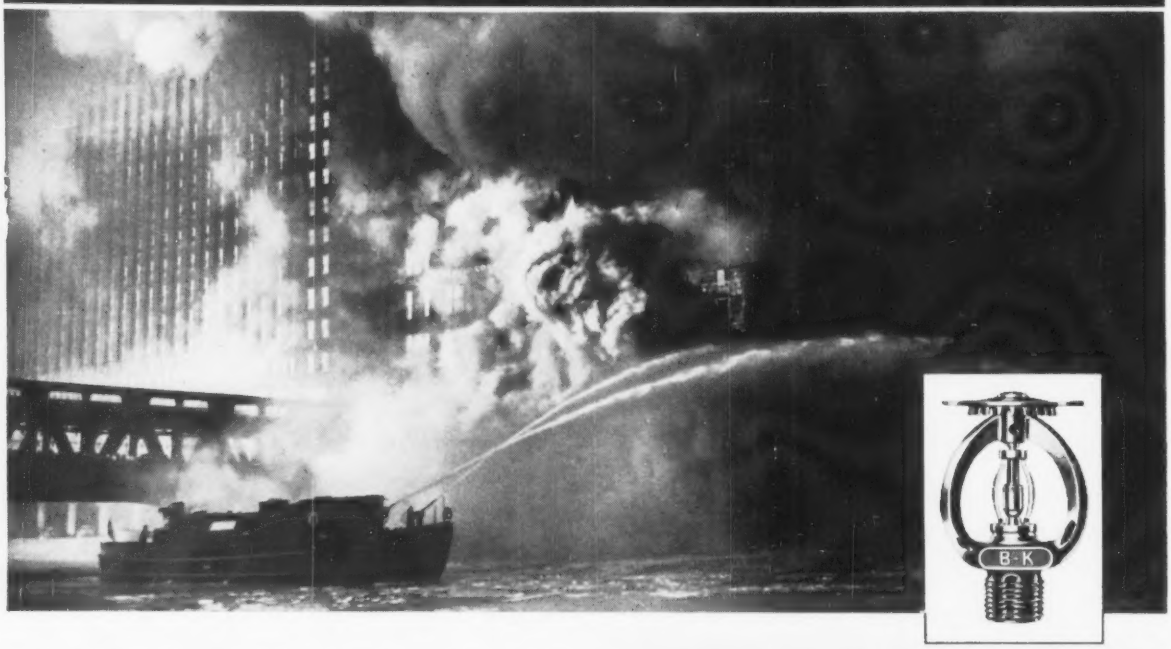
Many years of experience with industrial water problems in all parts of the country is the reason why Calgon Engineering Service can provide reliable protection for your plant. A letter or phone call will put one of these experts to work for you.

*Calgon is the Registered Trademark of Calgon Company for its sodium phosphate glass (sodium hexametaphosphate) products. The use of polyphosphates for the prevention of corrosion is covered by U. S. Patent 2,337,856.

CALGON COMPANY

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO

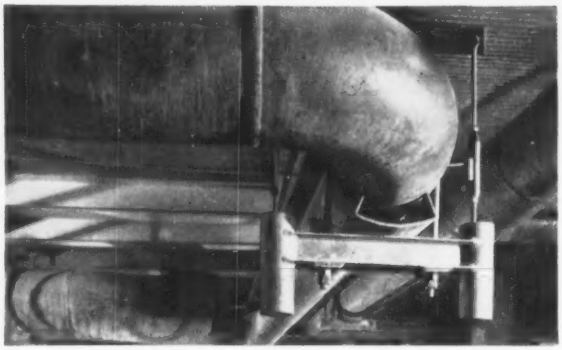
BLAW-KNOX has what it takes—to provide these products and services



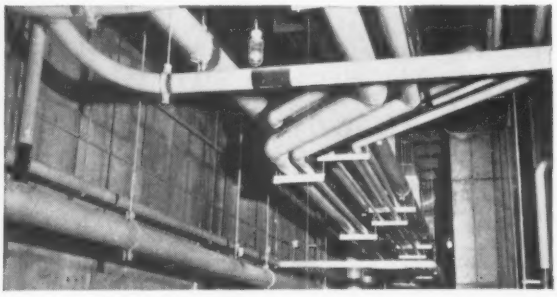
A Blaw-Knox automatic sprinkler system could have prevented this disastrous fire. Each year a serious fire strikes one out of seven manufacturing firms in this country. And out of every 100 firms who lose their records in a fire, 43 never reopen for business. So why take any chances.

Blaw-Knox engineers, fabricates and installs automatic sprinkler systems that are always alert to detect, confine and quench a fire at its origin. Qualified engineers custom-design systems that meet individual requirements—and fulfill all insurance standards and municipal codes. A Blaw-Knox automatic sprinkler system pays for itself in a few years through savings in reduced insurance premiums.

Let a Blaw-Knox fire-protection engineer study your needs, submit a layout and estimate, and tell you how you can pay for the system on our lease or deferred payment plan. For more complete information, write for Bulletin No. 2426—"Fire Can Destroy Your Business."



Blaw-Knox trapeze functional spring hangers, with the patented internal swivel action, support power piping in new generating station. Our experienced engineers are available to both design and make recommendations for your hanger requirements. For further information, send for Catalog No. 54.



High temperature, high pressure oil tunnel piping in large steel mill is typical of many piping systems prefabricated and erected by Blaw-Knox. Experienced piping engineers, modern shop facilities and a new Blaw-Knox digital computer method for fast, accurate calculation of piping stresses are available to you. Let us know your requirements and we will provide the service you need. For additional information, write for Bulletin No. 2443—"Piping for Industry."

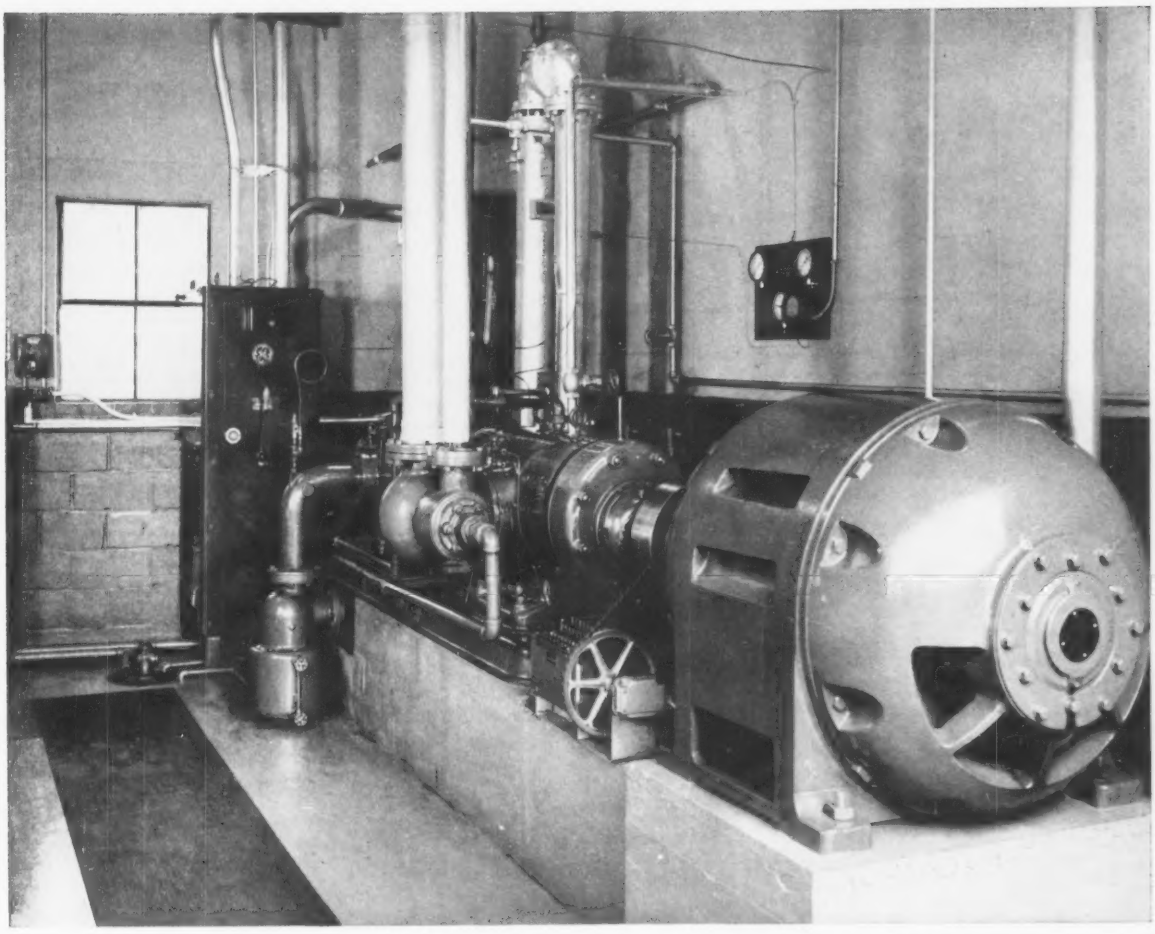
BLAW-KNOX

BLAW-KNOX COMPANY

Power Piping and Sprinkler Division

829 Beaver Avenue • Pittsburgh 33, Pennsylvania

Complete facilities for prefabrication and erection of piping systems for all pressures and temperatures . . . complete line of standard and custom-engineered pipe hangers, supports and vibration eliminators . . . complete line of automatic sprinkler systems for standard and special hazards



Fuller Rotary Two-Stage Compressor, C135-135H. Capacity 680 c.f.m., 100-lb. pressure, 690 r.p.m., 150 hp. motor.

16,000 HOURS OF OPERATION WITH NO MAINTENANCE

Empire Steel Castings, Inc., Reading, Pennsylvania, installed a C-135-135H Fuller Rotary Two-stage Compressor in April 1953. After 32 months—approximately 16,000 hours of operation—the compressor received a routine inspection, when a new set of blades was installed in the higher-pressure cylinder.

The Empire engineers report no down-time since replacement, although they've added 4,000 operating hours. Prior to switching to Fuller, their former experience with compressors was a different story—as many as several overhaulings in one year. With Fuller equipment furnishing a constant high capacity air supply, production costs have been greatly reduced.

Here's how Empire uses compressed air:

- In the molding department, supplying all air for pneumatic rammers, all squeeze and jolt machines, automatic set-out and lifting apparatus of mold conveyors, automatic shake-out machines, mold cleaning and spraying equipment.
- In the core department, for ramming equipment, spraying and torch drying equipment, core oven operation as well as core blowing equipment.
- In the cleaning department, pneumatic chipping hammers and grinders, blacksmith requirements, sand-blasting, pressure testing and miscellaneous tools.
- In the heat-treating department, heat treating furnace operation and cooling equipment.

To get all the facts and engineering data, write today for Bulletin C-5A.

C-298
3662

FULLER COMPANY
GENERAL AMERICAN
TRADE MARK

FULLER COMPANY
126 Bridge St., Catasauqua, Pa.
SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
Chicago · San Francisco · Los Angeles · Seattle · Kansas City · Birmingham

Fuller

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

"Joe, you wouldn't buy the engine of your car from one manufacturer, the wheels from another and the body from still another, would you? Neither would I. And when I design for induced draft, I specify a P-D Stack because the I.D. Fan, though it is important, isn't the whole story. The combined breeching, stack and fan, built as ONE apparatus, gives me unit responsibility, compact design, simplified engineering, and positive performance, with a lot less purchasing details.

"Another thing, I'd rather buy my Dust Collector from the same manufacturer that made my Stack and Fan. For this is all part of the same system for handling the gas after it leaves my boiler unit.

"There's nothing like putting all the responsibility on ONE manufacturer's shoulders if you can, for then you'll come out on the long end nine times out of ten. Buying such equipment piece-meal is antiquated and costly."

You can save a lot of time, trouble and money by purchasing your Stack and Dust Collector from Prat-Daniel.

Write for data.

Project Engineers

THE THERMIX CORPORATION

P.O. Box 1189-1, GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD., Montreal 25, Que.

Designers and Manufacturers

PRAT-DANIEL CORPORATION

SOUTH NORWALK, CONN.

POWER DIVISION: Tubular Dust Collectors, Forced Draft Fans, Air Preheaters, Induced Draft Fans, Fan Stacks

TRERICE PATENTED STEAM TRAPS HAVE A ROTATING VALVE...ASSURING NO LEAKAGE DUE TO WIRE DRAWING

With every discharge, the valve in a Trerice trap seats in a different position . . . a new seat . . . a steam tight seat every time! Discharging water impinges on the impeller . . . causes rotating action.

EASIER MAINTENANCE

A Trerice trap can be inspected and cleaned without removing it from the line, or disturbing the high pressure bolts and gasket. Removable cap permits quick access to valve and seat for inspection and maintenance.

FREE TRIAL OFFER

We'll supply one, a dozen, or more Trerice steam traps for your operation on a FREE 60-day trial basis. Act now! Write today for bulletin 1400D containing complete engineering data, valve and orifice charts.

H. O. TRERICE CO. 1420-A W. Lafayette Blvd., Detroit 16, Mich.
Sales Offices in Principal Cities of U.S.A. and Canada

Write for

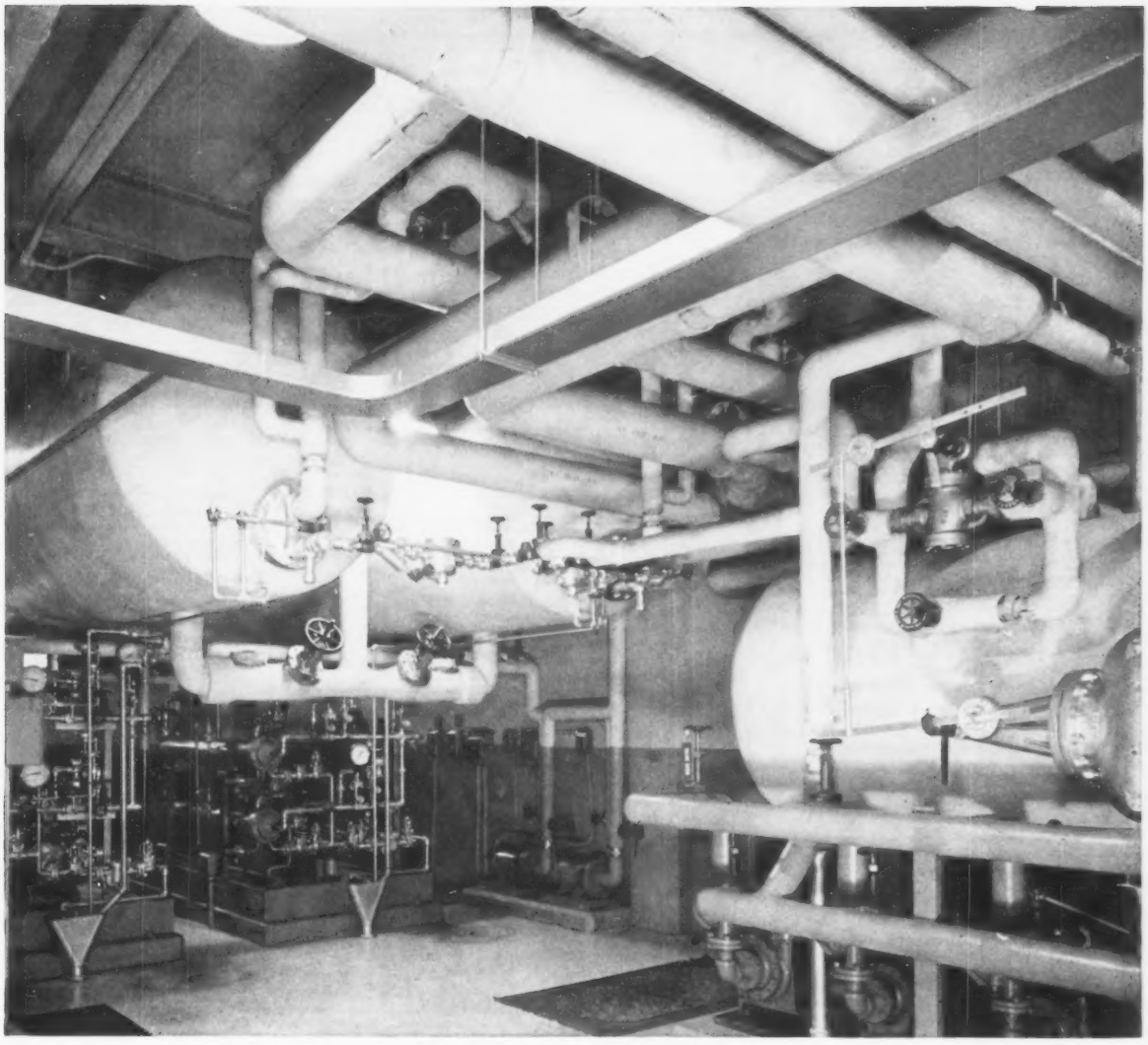
Power's
REPRINT FOLDER

...SUMMARIES and PRICES

on **Power's** information-packed

SPECIAL REPORTS

"the most useful condensed handbooks in the power and plant service field."



K&M HIGH-PRESSURE INSULATIONS WITHSTAND VIBRATION AND TEMPERATURE CHANGES!

Minimize Fuel Costs As Long As The Equipment Lasts!

You get more heat from every fuel dollar. With K&M High-Pressure Insulation, your fuel costs remain low . . . your process control more precise. Even severe operating conditions can't interfere with its insulation efficiency.

K&M High-Pressure Insulations meet every need. For temperatures up to 1900°F., use K&M Hy-Temp Combination—diatomaceous silica overlaid with K&M "Featherweight" 85% Magnesia. Staggered joints prevent heat loss through expansion-caused openings. For temperatures up to 1350°F., use K&M Kaytherm—hydrous calcium silicate bonded with asbestos fibers—important for power and petroleum applications. For temperatures up to 600°F., use K&M "Featherweight" 85% Magnesia—a basic carbonate of magnesia mixed with asbestos fibers. K&M High-Pressure Insulations come in a variety of sizes and thicknesses . . . in pipe and block insulation.

Write today to us for more information.

K·M
BEST IN ASBESTOS

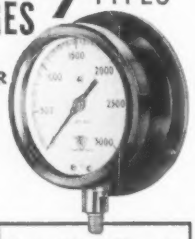
KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

In Canada: Atlas Asbestos Co., Ltd., Montreal, Toronto, Winnipeg, Edmonton, Vancouver

WHERE TO BUY

HI-RELIABILITY KUNKLE GAUGES ALL TYPES

FOR PROCESS AND POWER INSTRUMENTATION



Guaranteed accuracy. Backed by 50 years gauge manufacturing experience. Many "standards" in stock.

Ranges from 15 p.s.i., or 30" of vacuum, to 20,000 p.s.i.

Bourdon tubes of bronze, drawn or bored s/s and other alloys

NEW CATALOG AND ENGINEERING DATA MAKES SPECIFYING EASY . . . GET IT FROM

The makers of dependable Kunkle Valves

KUNKLE VALVE CO. • FT. WAYNE, IND.

STEEL PIPE & TUBING

• CHROME MOLY • CARBON MOLY • STAINLESS • CARBON STEEL • VALVES & FITTINGS

Widest Range of Sizes & Specs in the U. S.

WRITE FOR STOCK LIST

MIDCONTINENT TUBE SERVICE, INC.
2120 Lee St., Evanston, Ill. DA 8-4030

PAINTING CONTRACTORS

Specialists in

Power Plants, Refineries, Chemical Plants

HARTMAN-WALSH

5078 Easton St. Louis 13, Mo.

TO manufacturers of equipment and those offering special services to the power industry, this section offers an inexpensive means of keeping products or services regularly before your potential customers—The readers of POWER. The small spaces available here provide opportunity for you to be represented in every issue at low cost. Can we serve you?

•

Classified Advertising

POWER

PROFESSIONAL SERVICES

BLACK & VEATCH

Consulting Engineers

Electricity—Water—Sewage—Industry
Reports, Design, Supervision of Construction,
Investigations, Valuation and Rates

1500 Meadow Lane Pkwy, Kansas City 14, Missouri

SANDERSON & PORTER
ENGINEERS

Construction

Reports *Surveys*

New York New York

BURNS & McDONNELL

Engineers—Architects—Consultants

Kansas City, Mo. Phone
P. O. Box 7088 DElmar 3-4375

SARGENT & LUNDY

Engineers

140 South Dearborn St. Chicago, Illinois

GILBERT ASSOCIATES, INC.

Engineers and Consultants

Design and Construction Supervision
Mechanical • Electrical • Structural
Sanitary • Chemical Laboratory
Business and Economic Research

New York Reading, Pa. Washington

SEELYE STEVENSON VALUE & KNECHT

Consulting Engineers

Mechanical—Electrical—Civil
Surveys Reports Design

101 Park Avenue New York 17, N. Y.

INTERNATIONAL ENGINEERING COMPANY, INC.

Engineers

Investigations — Reports — Design
Procurement — Field Engineering
Domestic and Foreign

74 New Montgomery St., San Francisco 5, Calif.

J. E. SIRRINE COMPANY

Engineers

Power Plant Consultations
Design Reports
Water Steam Utilization Plants

Greenville South Carolina

THE KULJIAN CORPORATION

Engineers - Constructors - Consultants

POWER PLANT SPECIALISTS
(Steam, Hydro, Diesel)
Utility • Industrial • Chemical

1200 N. Broad St. Philadelphia 21, Pa.

STANLEY ENGINEERING COMPANY

Consulting Engineers

Hershey Building 208 S. LaSalle St.
Muscatine, Ia. Chicago 4, Ill.

PETER F. LOFTUS CORPORATION

Design and Consulting Engineers

Electrical • Mechanical • Structural
Civil • Nuclear • Architectural

First National Bank Building
Pittsburgh 22, Pennsylvania

SWANSON, WRIGHT & CO. ENGINEERS, LTD.

Consulting Engineers

Forest Product Industries
Thermal Power Plants
Industrial and Process

2210 West 12th Ave., Vancouver 9, B.C. CEdar 1154

LUTZ AND MAY COMPANY

Consulting Engineers

Steam Gas & Diesel Power Station
Pumping Plants—Electric Systems
Reports—Design—Appraisals

1009 Baltimore Kansas City 6, Mo.

TIPPETT & GEE CONSULTING ENGINEERS

Mechanical—Electrical—Thermodynamic—Structural
Design—Studies—Supervision
Power Stations—Transmission—Distribution
Industrial Plants—Process

1333 North Second Street Abilene, Texas

CHAS. T. MAIN, INC.

CONSULTING ENGINEERS

Design—Construction Management
Steam, Hydroelectric & Diesel Plants
Gas Turbine Installations
Transmission—Distribution

Boston, Mass. Charlotte, N. C.

WATER SERVICE LABORATORIES, INC.

Specialists in Water Treatment for corrosion Prevention

Main Office:
615 West 131 Street New York 27, New York
Offices also in Phila., Wash. & Richmond, Va.

PIONEER SERVICE & ENGINEERING CO.

Consulting and Design Engineers
Purchasing
Specialists in
Financing, Accounting Other Operations
231 So. La Salle St. Chicago 4

THE J. G. WHITE ENGINEERING CORPORATION

Design-Constuction-Reports-Appraisals

80 Broad Street, New York 4

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE

(Not available for Equipment Advertising)
$1.65 a line. Minimum 3 lines. To figure advance payment count 5 average words as a line. (See ¶ on Box Numbers.)

POSITION WANTED undisplayed rate is one half of above rate, payable in advance.

BOX NUMBERS count one additional line.

INFORMATION:

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

An ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

DISPLAYED RATE

The advertising rate is $17.90 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

EMPLOYMENT OPPORTUNITIES — $25.00 per inch subject to agency commission.

Send New ADS or Inquiries to Classified Adv. of Power, P. O. Box 12, New York 36, N. Y., For April Issue Closing March 11th

ADDRESS BOX NO. REPLIES TO: Box No.
Classified Adv. Div. of this publication.
Send to office nearest you.
NEW YORK 36: P. O. BOX 12
CHICAGO 11: 520 N. Michigan Ave.
SAN FRANCISCO 4: 68 Post St.

POSITIONS VACANT

Electrical Engineer: Graduate electrical engineer with one to five years of experience for progressive midwestern paper mill. All replies held strictly confidential. P-6903, Power.

Assistant Superintendent for municipal Light & Power Department, pop. 20,000. Should be graduate Electrical Engineer with 3 years experience in generation, transmission distribution and some administration. P-5817, Power.

Wanted District Chief Stationary Engineer, For Yellowstone Park. To supervise operation, maintenance hotel and lodge H.P. steam electric plants, ammonia ice and refrigeration systems, complete laundry. Must be able to direct men, deal with management. Having 12-15 years practical experience, college or high school education; with good background knowledge of steam, electricity, refrigeration and mechanical work, some plumbing and heating experience required. Seasonal, May through September, for details and application form write. Yellowstone Park Co. Engineering Dept. Box 296, Gardiner, Montana.

Wanted Stationary Hotel Engineer, For Yellow-stone Park. To operate H.P. steam plant generating own current, ammonia ice and refrigeration system, complete laundry. Must be able to supervise men, deal with management. Have 12 to 15 years practical operating experience; with good background knowledge of Unaflow engines, pumps, electricity, ammonia refrigeration and mechanical work, some plumbing and heating experience required. Seasonal, five months May through September. For details and application form write. Yellowstone Park Co. Engineering Dept. Box 296, Gardiner, Montana.

SELLING OPPORTUNITY OFFERED

Agents Wanted: To represent old established chimney builder in Detroit, Louisville, Minneapolis, Kansas City and other large cities. Excellent adjunct for an existing boiler accessories representative. RW-7150, Power.

POSITIONS WANTED

Power Plant Superintendent, age 36, technical education, 12 years experience in the operation, maintenance and plant betterment of turbo-electric power plants. PW-6856, Power.

M.E. Req. Minn. Age 40, 20 yrs. exp. Pwr. pip-ing, Blrs., Turbines, Design, Const., Estimating Exp. Prefer South or Southeast location. Write PW-7063, Power.

SELLING OPPORTUNITY WANTED

Attention Sales Managers—Well known manu-facturers' representative of engineering specialties (steam, water and air) wants to carry your quality line in the New York area. RA-7314, Power.

WANTED

Anything within reason that is wanted in the field served by Power can be quickly located through bringing it to the attention of thousands of men whose interest is assured because this is the business paper they read.

WANTED

Complete power plants, turbo generators, Boil-ers, Condensers, Engine generators, Processing Plants and equipment.

PAUL OBERMAN
1910 Delmar St. Louis, Mo.

WANTED

NON-CONDENSING STEAM TURBINES
500-2000 KW
TRANSFORMERS—AIR COMPRESSORS
ELECTRIC MOTORS

PAUL JAY
Box 4844 Normandy Miami Beach, Fla.

WANTED WATER WHEEL TURBINE

400 KW, 3 phase, 60 cycle, 4160 volts—37 ft. head, vertical. *State age, condition, location and price.*

ALJON ELEC. DIESEL COMPANY
904 Pacific St., Bklyn. 38, N. Y.

WANTED

150-200 H.P. Scotch Boiler
with burner & etc.—Late Model.

AURORA LAUNDRY CO. INC.
562 So. River St., Aurora, Ill.

DIESEL GENERATOR BARGAINS

Located in Canada

4—500 KVA 3/60/4000 volt 360 RPM with eleven panel switchboard.
2—750 KVA 2300/3/60—GE—5 cylinder 300 RPM switchboard included if both units are purchased.
1—375 KVA 480/3/60 Westinghouse—6 cylinder Fairbanks Model 32 Style UA with switchboard suitable for two such units with voltage regulator. Good condition.
1—375 KVA 3/60/2400-4160—300 RPM Fairbanks new 1947—May be inspected in operation—Good condition.
1—250 KVA 3/60/440 (originally 2300) Fairbanks 8 cylinder Y—switchboard—sacrifice for quick sale.

Many other sizes and types—Our 47 years in business has given us a large connection—Send your enquiries and surplus lists.

SOUL CLINIC INC.—CALGARY—CANADA

"SEARCHLIGHT"
IS
Opportunity Advertising

—to help you get what you want—to help you sell what you no longer need.

Take Advantage Of It

For Every Business Want

"THINK SEARCHLIGHT FIRST"

FOR SALE

PACKAGE BOILER

28,000 pounds steam per hour Babcock & Wilcox Package Boiler, type FM9, size 61, integral furnace, 175# steam pressure, oil or gas fired, mounted on steel skids, complete with automatic control.

New 1953 — Excellent Condition

INTERNATIONAL POWER MACHINERY CO.
1612 Union Commerce Bldg.
Cleveland 14, Ohio Main 1-9514

1500 JEFFERSON
LINE DISTRIBUTION TRANSFORMERS
NEW INDIVIDUALLY CRATED
4000 VOLTS AC PRIMARY
120 VOLT 60 CYCLE SECONDARY
500 WATTS
WEATHERPROOF CONSTRUCTION
ORIGINAL COST $68.00
NOW—SPECIAL $15.0 EA.
32 VESTRY ST., NYC 13
DISCOPHONE SALES CO., INC.
32 VESTRY ST., NYC 13 WOrth 6-0512

FOR SALE
CAR SHAKEOUT
(Hewitt-Robins)
Mod. HD—20 H.P. Motor
Excellent Condition
PHILIP A. HENAULT
26799 W. Eight Mile Rd., Detroit 40, Mich.

FOR SALE

(1) Keeler 100 H.P. C.P. Boiler, 125 lbs, assembled on skids, complete with blow down, safety, non return, header, and water feed valves. Supplied with combusion air fan, gauges & columns.

TRUBEK LABORATORIES, INC.
East Rutherford, New Jersey

FOR SALE

Thermix induced draft fan and fifty foot stack. Mfg. by Pratt Daniel Co., Capacity—50,000# Gas per hour.

Never Used — Make an Offer:

NANTUCKET GAS AND ELECTRIC CO.
P.O. Box 179, Nantucket, Mass.

STEAM TURBINE GENERATOR

G.E. 25 KW. Operates on high pressure steam. Purchased new and used less than 100 hours.
Excellent Condition

Contact MR. JAMES RIVES
CARLINVILLE AREA HOSPITAL
Morgan St. Carlinville, Illinois

Industry Approved . . .

ELECTRIC POWER EQUIPMENT

REBUILT BY CHICAGO ELECTRIC

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
2500	*G.E.	MT (Mill Type)	257
1100	*G.E.	MT	720
1000	*G.E.	M-575-S	1200
1000	*West.	CW	450
600	*G.E.	M-6345-S	1800
500	G.E.	M-6345	1200
400	*G.E.	MTP-565	1200
350	*Al-Ch	ARYW	1800
300	Cr-Wh	SR70-R	1800
250	Al-Ch	ARY-626	1800
250	*G.E.	I-M-17A	720
200	G.E.	I-M-16	600
200	*West.	CW1950A	514
150	Cr-Wh	SR-50R	1800
150	G.E.	I-M-15A	600
125	G.E.	I-M-15A	600
100	G.E.	I-E-13A	1800
100	G.E.	MT558	720
100	G.E.	I-M-15A	425
75	West.	CW-770	1200
75	G.E.	MT-347	1200
75	G.E.	MT-356	900
75	G.E.	MT-352	720
75	G.E.	I-M-10	600
60	G.E.	MT-536	1200
60	*West.	CW-762C	900
50	*G.E.	MT-536	1200
50	Al-Ch	ARY-223	900
50	West.	CW-753	720
50	Al-Ch	ANY-26	600
40	G.E.	MT-532	1200
40	G.E.	MT-336	900

HUNDREDS OF SLIP RINGS OF SMALL SIZES — ALL SPEEDS

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
1750	*G.E.	K	3600
1750	*G.E.	K	1800
1250	*Al.-Ch.	ANX	3600
600	West.	CS	720
600	*G.E.	K-63455	1200
500	*G.F.	K-63455	1200
500	*G.E.	I-13-E	900
350	*G.E.	KT-559-A	1800
300	*G.E.	K6344	1200
250	*W (TE)	CS-81205	1800
250	*G.E.	KT-599-S	1800
250	*West.	CS-875-S	1800
250	Brook	RS28	1200
200	*G.E.	FT-540	3600
200	West.	I-K-13B	1800
200	Brook	CSP-581-S	1800
200	*West.	RS-27	1200
200	G.E.	CS-930-A	900
200	*Al-Ch	KT-564-S	720
200	*West.	AN-37-G	720
200	Al-Ch	CS-1010	600
200	*G.E.	ARW-631	600
150	Cr-Wh	SC-140	3600
150	Al-Ch	AN-30-F	1200
150	West.	CSP-5815	1200
150	G.E.	I-K-15A	900
150	*West.	CS	600
125	Al-Ch	AR-226	1800
125	Cr-Wh	5-Q	1200
125	G.E.	K-558	900
100	W (TE)	CS-507-S	3600
100	G.E.	FT-542-Z	1800
100	Al-Ch (TE)	ARZ-826	1200
100	Al-Ch	AW-23-D	1200

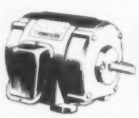
YOU GET THESE ADVANTAGES!

1. **50% to 80% COST SAVINGS!** You can have the particular equipment your want at a tremendous savings!
2. **NEW EQUIPMENT PERFORMANCE!** Fully reconditioned to perform as per nameplate specifications—AS GOOD AS NEW!
3. **FULLY GUARANTEED!** Your complete satisfaction fully guaranteed on all equipment and every transaction!
4. **LIBERAL TRADE-IN'S!** Tremendous inventory necessitates extensive buying—we must trade higher!

SPECIAL NEW WESTINGHOUSE

Single Step, Primary resistance magnetic Squirrel Cage Motor Starters. 3/60/—Class 11-400

Phone CAnal 6-2900



CHICAGO Electric Co.

1320 WEST CERMAK ROAD • CHICAGO 8, ILLINOIS

2 OIL BURNING BABCOCK & WILCOX WATER TUBE BOILERS

Designed for T2-SE-A2

Now being removed at Philadelphia, Pa., from the S.S. Mission San Francisco.

Complete with deaerating feed heaters, Coffin feed pumps, oil pumps, 1st, 2nd & 3rd stage heaters. Evaporation: normal 43,000 lbs.; max. 60,000 lbs. Designed boiler pressure 700 P.S.I. Final steam temp. at superheater outlet 825° normal. Superheat safety valve setting 624 P.S.I. Boiler heating surface including water wall 6350 sq. ft. Total water heating surface 8030 sq. ft. Economizer heating surface 1680 sq. ft. Operating pressure superheater outlet 600 P.S.I. Furnace volume 573 cu ft. Evaporation rate from and at 212 F lbs/hr/sq ft of total boiler heating surface: Normal 8.33—max. 11.74. Water wall heating surface 118 sq ft. Feed water temp 240 F. Immediate delivery. Presently on barge at Philadelphia. Dimensions: 19'8" high over drum flange: 14' 9-5/16" over casing plate; 16' wide over drum.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

COMPLETE DIESEL PLANT

2—Fairbanks Morse 450 HP Model 32E14 375 KVA. 3/60/2400 volts. With complete auxiliaries. New in 1944.

1—Fairbanks Morse 360 HP Style VA, 257 RPM 300 KVA. 3/60/2400 volts. With auxiliaries.

These units can be purchased individually at a real bargain price. Condition is first-class.

WHISLER EQUIPMENT CO.
611 Olive St. St. Louis 1, Mo.
CH. 1-4474

G.E. STEAM TURBINE GENERATORS OFFERED AT A SMALL FRACTION OF REPLACEMENT COST

(Not an actual photo but similar)

375 lb. throttle pressure, single & double automatic extraction—non-condensing 3 phase 60 cycle 480 volts.

1—1500 KW extraction, 150 lbs. exhaust 85.
1—2000 KW extraction, 150 & 85 lbs. exhaust 10 lbs.
1—2500 KW extraction, 150 & 85 lbs. exhaust 10 lbs.

All complete with breakers, voltage regulators and miscell. accessories. Ideal for Paper, Sugar & Chemical Industries. Mfd. in 1933.

JOLIET EQUIPMENT CORP., Box 1078, Joliet, Ill.

FOR SALE

2 B&W #144 COAL PULVERIZERS
Like New Ball Mills Driven by 100 HP, 2300V Motors.

CHARLES WEAVER, INC.
19701 James Couzens Hwy.
Detroit 35, Mich.
Phone: BRoadway 3-1900

FOR SALE

2812 KVA DIESEL GENERATOR UNIT

2812 KVA Crocker Wheeler generator, 3 phase, 60 cycle, 12,000/6900/4160/2400 volts direct connected to 3000 HP Busch-Sulzer (Nordberg) diesel engine, 10 cylinders, 240 RPM complete with auxiliaries as in operation.

Used only 5 years. Excellent condition

INTERNATIONAL POWER MACHINERY COMPANY
1612 Union Commerce Building
Cleveland 14, Ohio Main 1-9514

FOR SALE

18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired. *Price reasonable.*
Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
706 DONOVAN BLDG.
DETROIT 1, MICH.

FOR SALE

MODERN POWER PLANT

1875 KVA TURBINE 400 PSI, 700°F Condensing, 2300 Volt GENERATOR 25000#/Hr 450 PSI, BOILER: includes all auxiliaries, & 25 Ton CRANE.

Will sell complete or separately

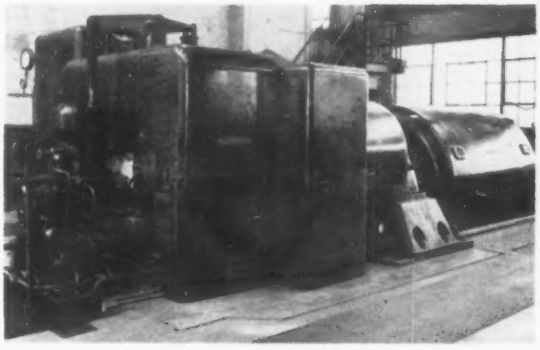
COMBUSTION ENGRS. BOILERS

175 HP 275 PSI oil fired M-2 Package (3) 75000#/Hr 650 PSI oil fired size 27VA forced & induced draft fans, Deaerating Heater preheater.

HEAT & POWER CO., INC.
Power Equipment Div.
60 East 42 St., New York 17, N. Y.
310 Thompson Bldg., Tulsa 3, Okla.

EXCLUSIVE OFFERING!

650 lb., 725 DEG. TURBO-GENERATORS — Just Purchased as Released from Service — Available Now — Very Modern — 7500 KW, 80% PF, Westinghouse Unit



ACTUAL RECENT PHOTOGRAPH

Above exceptionally fine unit placed in service in 1949 and constantly maintained in excellent condition. Turbine designed for 650 P.S.I.G., 725° F.T.T., automatic extraction at 125 P.S.I.G., Westinghouse Generator 9375 KVA, 7500 KW, 6900 volt, 3 phase, 60 cycle, 3600 RPM, with dir. conn. 125 volt exciter. Complete with surface condenser, switchboard, voltage regulator and operating auxiliaries.

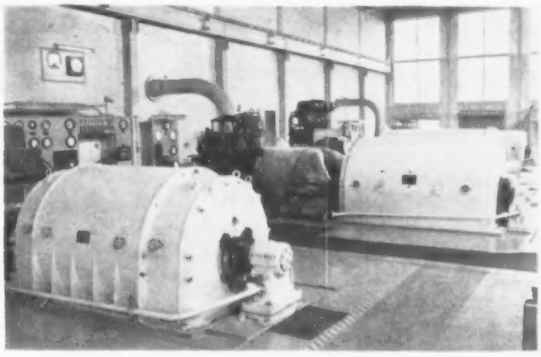


PHOTO OF OTHER AVAILABLE WHSE. TURBO-GENERATORS

These additional units in other power plant — same location — here locally where recently discontinued from service. All designed for 650 P.S.I.G., 725° F.T.T., Westinghouse Generators 6600/6900 volt, 3 phase, 60 cycle, 3600 RPM.

1—9375 KVA, 7500 KW, 125 P.S.I.G. auto extraction, surface condenser, installed in 1937.

1—9375 KVA, 7500 KW, non-condensing, 125# B.P., installed 1930.

1—6250 KVA, 5000 KW, Condensing, with surface condenser, installed 1942.

1—5000 KVA, 4000 KW, non-condensing, 125# B.P., installed 1927.

1—5000 KVA, 4000 KW, 380 P.S.I.G., non-condensing, 125# B.P., installed 1930.

All units complete with operating auxiliaries.

Can be inspected where installed — Bargain Prices.

•

BELYEA CO. INC.

43 HOWELL STREET **JERSEY CITY 6, N. J.**

N. J. Phone: OLdfield 3-3334

N. Y. City Phone: REctor 2-7150

MISS POWER EQUIPMENT SAYS,

"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed New and Rebuilt Motors"

REBUILT

HP	Make	Type	Speed
400	West. B.B. Drip.	CSP-681S	1800
400	West. S.B. Open	CS	900
350	A.C. S.S. Drip	ARWW-628	3600
300	G.E. S.B. Open	IK	1800
300	A.C. S.B. Open	AR-630	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open		

SQUIRREL CAGE MOTORS NEW AND GUARANTEED

		CS-1002	600
250	G.E. TEBB, 2300 V	K	1800
250	G.E. S.B. Open	KT	1800
250	F.M. B.B. Open	H	1800
250	G.E. S.B. Open 2200 v	IK-16	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. S.B. Drip	K-6326	3600
200	F.M. B.B. Open	H-207	1800
200	G.E. TEBB	K	1800
200	A.C. S.B. Open	ARW-626	1800
200	G.E. S.B. Open	AT-558	1800
200	Cont. T.E.F.C. B.B		1800
200	GE. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-15S	1200
200	G.E. S.B. Open	KT-562	1200
200	G.E. S.B. Open 2200V	IK	1200
200	G.E. S.B. Open	IK	900
200	Cont. T.E.F.C.B.B.	NP686C	1800
200	G.E. S.B. Drip	K6334S	1200
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	G.E. TEBB	K	1800
150	West S.B. Open 2200V	CS	1800
150	G.E. S.B. Open	IK	1800
150	West. S.S.B. 2200V Open	CS-772C	1200
150	G.E. S.B. Open	KT-558	900
150	Cont. T.E.F.C. B.B. New		900
150	G.E. B.B. Open	KT-558	900
150	G.E. S.B. Open	IK	720
150	West. S.S.B. Opn	CS-761C	1800
125	G.E. TEFCBB	K	3600
125	West. S.S.B. Open New	CS-607	1800
125	G.E. S.B. Drip	K-505	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open	CS-716C	1800
125	G.E. S.B. Open	KT-553	1200
125	G.E. S.B. Open	IK	1200
125	G.E. S.B. Open	IK	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	800
100	A.C. B.B. Open	AR-423	3600
100	A.C. S.B. Open	AR-505B	3600
100	G.E. S.B. Open	KT-343	1800
100	A.C. S.B. Open 2200 V	ARX	1800
100	G.E. S.B. Open	KT-347	1200
100	West. SSB Open	CS-607	1200
100	West. SSB Open	CS	1200
100	A.C. SB Open 2200 Volt	ARX	1800
100	G.E. S.B. Open	IK	900
100	Howell B.B. Open	NC-684	900
100	G.E. S.B. Open	KT-356	900
100	G.E. S.B. Open	IK	720
75	West. T.E.F.C. B.B.	New CS-754C	1200
60	Wagner T.E.F.C.B.B.	New CP-504	1200
60	Wagner T.E.F.C.B.B.	New CP-505	900
50	Wagner T.E.F.C.B.B.	New CP-445	1200
40	L.A. T.E.F.C.B.B.	XP EX-405	1800

CASH FOR YOUR SURPLUS

NEW & USED Electrical Equipment

•

SEND YOUR LIST TODAY!

FREE CATALOG. This is a partial listing. We are continually changing our stock, and can fill your requirements at any time. Send for our free catalog. In Stock, fractional horsepower up to 500.

Large line of motors, Control Equipment, AC and DC Generators, MG sets and transformers. PHONE or WIRE us COLLECT

POWER EQUIPMENT CO.

8 CAIRN STREET • PHONE GEnesee 8-5629 • P.O. BOX 534 • ROCHESTER 2, N.Y.

STEAM TURBINE WITH 150KW GENERATOR

Elliot Turbine, 135# intake pressure, 15# exhaust, Elliot Gear Reducer—1200 RPM output. Allis-Chalmers Generator, direct coupled, 150 KW, 208 Volt, 520 Amp, 3 Phase, 50° Rise, .8 P.F. Automatic start, manual stop operation. Wall mounted panel with voltage regulator, volt meter, ammeter, rheostat, exhaust and throttle pressure gauges. Like new condition and less than one year old. Can be inspected in operation. Phone, wire or write

NAGLE-HART TRACTOR & EQUIPMENT CO.

P. O. Box 272, Madison 1, Wisconsin, Phone: ALpine 5-9444

FOR SALE—EXCEPTIONAL BARGAINS

Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets—Rotary Converters—Synchronous Condensers—
Frequency Changers—Transformers—Pumps, Boilers.

UTILITIES MACHINERY CORPORATION

1965 East Sixth St., Cleveland 14, Ohio • PHONES: CHerry 1-0210 & CH 1-4070

DIESEL ENGINES — POWER MACHINERY

100 KW to 1500 KW

Diesel Generator Sets • Stationary • Portable • Mobile Motors and Generators

A. G. SCHOONMAKER COMPANY, INC.

MAIN OFFICE: Box 516, Sausalito, Calif. Sausalito 1600 — BRANCH: 50 Church St., N. Y. 7, N. Y. Digby 9-4350

COMPLETE SWITCHBOARD DESIGN & CONSTRUCTION
USED & REBUILT EQUIPMENT
DIESEL SALES & SERVICE
GENERATORS—GAS OR DIESEL

UNIVERSAL POWER ENGINEERING CO.
217 COLDEN ST., JERSEY CITY, N. J.
Phone: DElaware 2-8300

72"x20' 150# Pressure HRT Boiler
426 HP B&W 3-drum WT Boiler
200 HP 150# WT Boiler w/oil burner
20,000 lbs. SPH at 200 psi Boiler
80-125-400 HP Package type Boilers
375 KVA Generator D/C Skinner Unaflow
150 KVA Gen. D/C F-M Diesel—EXCELLENT
30"x72" Power Baler—late type—good
H. & P., 6719 Etzel, St. Louis 14, Mo.

BARGAINS NEW CONDENSER

11000 SQ. FT. UNITS

3 New Worthington Surface Condensers—11000 sq. ft. each—single pass—Monel water boxes—Cupro-Nickel tubes & tube sheets. Tubes ⅝" O.D. CAPACITY: lbs/hr—70,000; circulating water 14180; circulating water connections 30"; operating weight 86,000 lbs; overall length approx. 21' width & height 9'4" Built for U.S. Navy. Designed for low head room.

8900 SQ. FT. UNITS

1 New unit by C. H. Wheeler. Test pressure: shell 30 lbs; water box 30 lbs.—single pass. Turbine steam exhaust inlet 6' 1¾" x 10' 2". Overall width 12' 2¼"; overall length 14' 10¾"; overall height 5'7". Water inlet 36" x 30" outlet. Monel heads and water boxes; Cupro-Nickel tubes. Built for U.S. Navy of very best materials.

1135 SQ. FT. UNITS

2 New Units by C. H. Wheeler. 2-pass—shell 30 PSI—tubes, chest 30 PSI: DIMENSIONS: 42" diam.—12' long. 24" exhaust steam inlet —water box inlet & outlet 10". 9300 lbs./hr. steam capacity; 1175 GPM circulating water. Complete with twin air ejectors type 4H Wheeler with inner cooler. Built originally for Navy.

580 SQ. FT. UNITS

6 New units—Capacity: 4300 lbs/hr on 28.5 vacuum. 8" water inlet & outlet—18" steam inlet. 2 pass— complete with air ejectors.

3 LIBERTY SHIP TYPE UNITS

2700 Sq. Ft.—2-pass type.

OTHER SIZES IN STOCK FOR IMMEDIATE DELIVERY

NEW CIRCULATING PUMPS

1 only—vertical circulating pump—all-bronze propeller type—geared turbo driven—840 RPM —26500 GPM at 25' head. W.P. turbine, Westinghouse, 575 lbs—0°F superheat. Pump—Warren type 25 VP.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

TRANSFORMERS

3—833 KVA, 1/60/34500-460 Moloney OISC with taps
2—250 KVA, 1/60/2400-240/480 Moloney OISC, type YC, with taps
1—300 KVA, 3/60/4160-240 Wagner, ITE type HPE Unit Substation, Outdoor.
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
1—225 KVA 3/60/440-208Y/120, Moloney Dry type.
4—15 KVA, 1/60/240-480/120-240 Moloney Dry type

CASH
For Surplus Electrical Equipment
BENSON-WILIMZIG, INC.
1708 North 8th St., St. Louis 6, Mo.
Phone GArfield 1-4290

BARGAIN OPPORTUNITY

600 HP—720 RPM, General Motors Model 567 Electro Motive Diesel engine direct connected to a:

500 KVA—400 KW at 80% PF, 720 RPM, 3 phase 60 cycle, 480 volt Westinghouse alternating current generator.

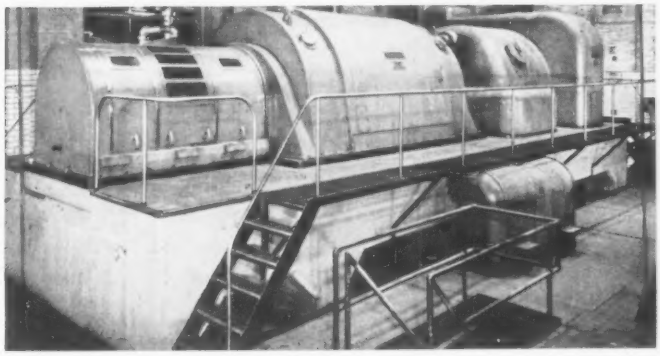
Complete installation. Equivalent to new.

EUCLID ENGINEERING CORP.
609 National City E. Sixth Building
Cleveland 14, Ohio

IMMEDIATELY AVAILABLE

650 LB. PRESSURE, 750° FTT TURBINE-GENERATORS

10,000 KW, 70% P.F., 14,286 KVA below:



This 10,000 KW is a Westinghouse, Condensing 650 Lb. PSIG, 750° FTT Turbine. It is equipped with Surface Condenser, Switchboard, with all auxiliaries, direct connected Exciter (closed type). Generator is 3/60/12000 V., 3600 RPM at 70% P.F., 14,286 KVA. Installed new in 1947.

CHARLES WEAVER, INC.

19701 James Couzens Hwy. **Tel: BRoadway 3-1900** **Detroit 35, Michigan**

---

500 KW PANEL BOARD

GENERATION CONTROL—UNUSED 220 VOLT A.C. OPERATION

Meters — circuit breaker — transfer switches — rheostat — disconnect switch — voltage regulator — reverse current relay. Free standing dead front modern type. Necessary components for parallel operations.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

POWER PLANT EQUIPMENT

SPECIAL OFFERINGS

TURBO-GENERATORS

1—3000 KW — 13,200 V — N. C. 425# — 170 Ext.—50# BP
1—3000 KW—4150 V 350# Cond.
2—2000 KW—6600 V—N. C. 625#—155# BP
1—1000 KW—240/480 V—Cond. 130/250#—Ext. #15
2—750 KW—250 V—DC—N. C. 250#—25# BP
1—300 KW—480 V—Cond. 210#—Ext. 40#
1—250 KW—240/480 V — N. C. 130# — 10/15# BP

DIESEL LOCO. CRANE

1—25 Ton—50 Ft. Boom.

A. LEE ELLIS CO., U.S. Machy. Bldg., 140 Federal St., Boston 10, Mass.
THE BUYERS MUST BE SATISFIED—ALWAYS

HIGH PRESSURE STEAM BOILERS

Government Surplus SAVE OVER 75%

NEW, NEVER USED, NEVER ERECTED, AVAILABLE IMMEDIATELY

121,650 Lbs.

1 Foster Wheeler
Express Type, 3-drum, with integral superheater separately fired.
Includes boiler, superheater, economizer, 7 fuel oil burners, soot blowers.
Pressure 634 psi, temp 850° F.
Furnace Vol: boiler 310 cu. ft., superh. 247 cu. ft.

60,000 Lbs.

10 Babcock Wilcox
3 Foster Wheeler
"D" Type, 2-drum, with integral superheater fired between boiler tube bank.
Includes boiler, superheater, economizer, 3 fuel oil burners, soot blowers.
Pressure 435 psi, temp 750°F.
Furnace Vol: 330 Cu. Ft.

55,000 Lbs.

1 Wickes Boiler
"A" Type, 3 drum.
Includes boiler, 3 oil burners, soot blowers.
Pressure 250 psi.
Furnace Vol: 420 Cu. Ft.

We own and stock these boilers. Inspection Invited at Utica, N.Y. Subject to prior sales.

PELNIK-LOCONTI INDUSTRIAL SUPPLY CO.

Office Ph. Utica 6-4621 • 315 Oriskany St., Yorkville, N.Y. • Yard Ph. Utica 2-4513

37 Years Dependable Service

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
800	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
400	4000/2300	Whse.	720
350	4000/2300	G.E.	720
300	2200	G.E.	450
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	220/440	Whse.	720
125	2200	G.E.	600
100	440/220	G.E.	720

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
800	2200/4000	Elliott	SC	1800
350	2300/440	G.E.	IE-K	1200
300(2)	2200	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
250	440/220	G.E.	KT	720
200	440/220	G.E.	KT	1800
200	2200	G.E.	KT	1800
200	440/220	G.E.	KT	720
200	2200/440	G.E.	IE-K	1200
150	440	Whse.	X-prf.	3600
150	2200	Al. Chal.	AR	1800
150	440/220	G.E.	KT	720
150	2200/440		KT	600
150	2200/440	G.E.	FT	1200
125(2)	2200/440	Whse.	X-proof	750
125	2300/440	G.E.	K	600
100(2)	4000/2300	L. Allis	OX	1200
75	2300/440	Whse.	TEFC	1200

A. C. GENERATORS

1—320 kva, 660 rpm, 2300/440/220 V., G.E.
1—360 kva, 900 rpm, 2300 V., Whse.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

3—1600 amp ITE, 2 pole, 600 V.
6—FKB-155-28, 600 amp., 15,000 V. G.E.
1—400 Amp., Condit. 3P, 25 KV outdoor
1—400 Amp. R. Smith, 3 P 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	SK	1800
200	230	Cr. Wh.	CMC	1200
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	850

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
125	G.E.	440	Sq. Ca.	250/125
100	G.E.	2200/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	240/120
65	G.E.	2300/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph
3—500 kva, G.E., 13,800—2300 V.
3—333 kva, G.E., 13,800—2300 V.
3—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
1—200 kva, Al. Ch., 6900—220 V., 3 ph.
3—200 kva, Whse., 4600/2300—230/115 V.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—150 kva, Al. Ch. 2400—220 V.
3—150 kva, Al. Ch. 440-220 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, G.E., 2400—120/240 V., Pyr.
6— 50 kva, G.E., 13800—120/240 V.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

FOR SALE

STEAM BOILERS

2—18000 lbs./Hr. Heine 175 psi, straight tube, oil fired, 1920

3—21000 lbs./Hr. Combustion Engr. 200 psi, Stoker fired, 1938

1—28000 lbs./Hr. B&W Package Type, Oil-Gas fired, 1953

1—35000 lbs./Hr. Combustion Engr. 450 psi, 825° stoker fired, 1950

SURFACE CONDENSER

1—2500 Sq. Ft Westinghouse, 2 Pass, with aux., 1950

DIRECT CURRENT GENERATORS

1—100 KW, General Electric, 250V, 1200 RPM, 1950

1—250 KW, Westinghouse, 250V, 720 RPM, 1950

MOTOR GENERATOR SET

1—25 KW, Westinghouse, 250V DC, 208/120V AC, 1800 RPM, 1950

WATER PUMPS

1—14000 GPM @, 370' Hd. De Laval Centrifugal, 690 RPM, 1800 HP, 1920

1—20800 GPM, @, 370' Hd. De Laval Centrifugal, 720 RPM, 2500 HP, 1949

1—24500 GPM @, 370' Hd. Worthington Centrifugal, 950 RPM, 3200 HP, 1954

STEAM TURBINES

1—1800 HP, De Laval Condensing, 165 lbs. psi 3600/690 RPM, 1920

1—2500 HP, De Laval Condensing, 400 lbs. psi 3600/720 RPM, 1949

1—3200 HP, Worthington Condensing, 175 lbs. psi 3600/950 RPM, 1954

INTERNATIONAL POWER MACHINERY CO.
1612 Union Commerce Bldg.
Cleveland 14, Ohio Main 1-9514

COMPRESSORS

1902-1958

WORLD'S BEST REBUILTS

100 CFM	125 psi	6x7 Ing. or Worth.
138 CFM	100 psi	7x7 Ing. ES-1
140 CFM	3500 psi	12½x10 Norwalk—unused.
268 CFM	500 psi	10-4¼x10 Ing. or Worth.
420 CFM	40 psi	12x9 Ing. oil-less (new cylinder)
465 CFM	100 psi	12x11 Penn. or Ing.
502 CFM	125 psi	12x13 Worth. HB.
503 CFM	220 psi	13½-7x13 Ing. St. or Elec.
585 CFM	100 psi	15-9¼x12 Ing. XRE 3-60-3160
590 CFM	100 psi	13½-8x8 Penn DE2 3-60-220
676 CFM	100 psi	15-9¼x12 Ing. XRB—Worth.
686 CFM	100 psi	14x13 Worth. HB.
790 CFM	100 psi	15½x9½x10 Ing. XRE 3-60-4800
800 CFM	125 psi	14½-9x7 Ing. XLE 3-60-440
870 CFM	125 psi	17-10½x12 Ing. XRE 3-60-220-440
1007 CFM	100 psi	19-11x12 Chic. OCB
1240 CFM	125 psi	19½-12x10 Ing. XVH 3-60-2300
1410 CFM	35 psi	20x13 Worth. HB—unused.
1721 CFM	125 psi	23-13x16 Chic. OCE 3-60-2300
2832 CFM	Vacuum	31x13 Ing. St. or Elec.
PORTABLES—55-60 CFM Rotary or Reciprocating		

American
AIR COMPRESSOR CORP.
DELL AVE. & 47th ST.
NORTH BERGEN, N.J.
Telephone UNion 5-4848

Save on Your INDUSTRIAL TRACK

FOSTER *QUALITY* — **FULLY GUARANTEED**

RELAYING RAILS

Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.

SEND FOR CATALOGS

RAILS - TRACK EQUIPMENT - PIPE - PILING
L.B. FOSTER CO.
PITTSBURGH 30 • NEW YORK 7 • CHICAGO 4
ATLANTA 8 • HOUSTON 2 • LOS ANGELES 5

SEARCHLIGHT EQUIPMENT SPOTTING SERVICE

This service is aimed at helping you, the reader of POWER, locate used and surplus new power equipment not currently advertised (this service is for user-buyers only).

Just send in the specifications of the equipment wanted on the coupon below, or on your own company letterhead, to

Searchlight Equipment Spotting Service c/o POWER 330 W. 42nd St., New York 36, N. Y.

Your requirements will be brought promptly to the attention of the used equipment dealers advertising in this issue. You will receive replies directly from them.

NO CHARGE
NO OBLIGATION

Searchlight Equipment Spotting Service c/o POWER 330 W. 42nd St., New York 36, N. Y.

Please help us locate the following used equipment:

NAME .....

TITLE .....

COMPANY .....

STREET .....

CITY .....

ZONE ..... STATE .....

3/58

BELYEA-RE-NU-BILT

LARGE ELEC. POWER EQUIPMENT
SELECTED STOCK ITEMS

RE-NU-BILT—GUARANTEED—RE-NU-BILT
COMBINATION MILL DRIVES—
D.C. MOTORS WITH M.G. SETS & CONTROLS
PACKAGE DRIVES IN STOCK

1—2250 HP Elliott 800 V. 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V. 450 RPM 3 ph. 60 cy.
1—1375 H.P. G.E., MCF, 415 V. 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V. DC, 2300/4000 V. 720 RPM 3 ph 60 cycle.
1—1200 HP G.E. MPC, 600 V. D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 HP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT	6900	1187
1	1100	F.M. BB	SF806S	4800/2400	1800
1	800	Whse.	CW	550	1776
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-15	440	1778
1	500	Whse.	CW	550	350
1	350	Cr. Wh.	SIZE-718R	208/406	1765
1	350	G.E.	IM-17A	440/2200	720
1	250	Whse.	CW-1039C		
			C-15	440	720
1	250	G.E.	MT-424Y	4000	367
1	250	Cr. Wh.	SIZE-290	2300	350
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
2	200	G.E.	IM	2200	435
2	200	Whse.	CW-890	2300	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-559AY	2300	3600
1	550	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
2	450	Whse.	CS-1420	2300/4150	354
2	400	Whse.	CS-7151-610T		
				6600/4000	3565
1	300	Elliott	BA-684Z	440	1770
1	125	Allis Ch.	AW-23FS	440	1170
1	400	G.E.	IK	2200	500
2	200	G.E.	KT-557	440	1800
2	200/150	Whse.	CS-963H	2300	1175/878
1	200	Whse.	CS-1002	2300/440	450
1	150	Whse.	CS	440	580
1	150	G.E.	IK-15A	2300	860

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
1	3500	G.E.	TS-6487P		
				4600/2300/4000	360
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/4600
1	2000	G.E.	514	600	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1500	G.E.	600	600	2300/4150
1	1000	G.E.	900	280	6600
2	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
1	350	G.E.	900	125	440/2300/4160
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El Mfg	1200	250	2300/4600
1	200	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/2300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300
1	100	G.E.	1200	250	4160/2400

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
3	3333	Whse.	OISC	1	13800x2300
1	1500	G.E.	PTRANOL	3 auto	4000/4300/4400
3	1000	G.E.	OISC	1	13800x460
2	750	G.E.	FUR	1	4800x35/55
3	500	KUHL	OISC	1	13800x6000
1	225	Marcus	Air	3 auto	208/220
3	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	660/11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	10000	Whse.	Condensing 650 lbs. 750° F.T.T. Surface Condenser Dir. Conn. Exciter.
2	3375	G.E.	650 lbs., 725° FTT, 150 lbs. G.B.P. non-condensing
1	2000	Al. Ch.	175 lbs., 5/30 lbs. G.B.P., non-condensing 3/60/480 volts

BELYEA COMPANY INC.

43 Howell St., Jersey City 6, N. J.

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P. OUR 52nd YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
500	G.E.	Slipring	2200/440	600
500	Whse.	Slipring	2200	450
450	El. Machy.	Synch.	2300/440	400
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
400	G.E.	Slipring	2300	514
350	G.E.	Sq. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2300/4000	600
300	El Machy (2)	Synch.	2200/440	720
300	G.E.	Slipring	2200/440	600
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Synch.	440	1200
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Whse.	Slipring	440	1200
250	G.E.	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	L.A. TEFC	Sq. Cage	440	1200
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Whse.	Sq. Cage	2200/440	900
175	G.E. (2)	Synch.	220/440	720
150	Rel. TEFC	Sq. Cage	220/440	900
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E.	Slipring	220/440	450
150	G.E. (2)	Sq. Cage	2200/440	1800
150	L. Allis b.b.	Sq. Cage	440	3600
125	G.E. TEFC	Sq. Cage	2200	3600
125	Ideal	Slipring	4000/2200	900
125	Allis Ch.	Sq. Cage	2200	900
100	Smith b.b. (6)	Sq. Cage	220/440	1800

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	G.E.	RC	600	1150
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CCD	250	650
125	Gen. Elec.	CD	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1200
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
50	Star b.b.	8Q	250	900
25	Whse.	SK-103	250	1750
20	Ideal	D-405	125	1150

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
200	G.E. b.b.	CY-299	230	1750
170	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	850
150	Whse.	SK-210	230	320/1000
150	G.E.	CD-173	230	575/1150
125	Reliance	651-T	550	1000/1600
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Reliance (3)	985-T	230	450/1200
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-514	230	1150/1750
50	Gen. Elec.	CD-95	230	1800
50	Star b.b.	SQ-92	230	680
50	G.E.	CD-125	230	400/1200
50	G.E.	RF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
30	G.E.	CD-113	230	500/1500

MOTOR-GENERATOR SETS

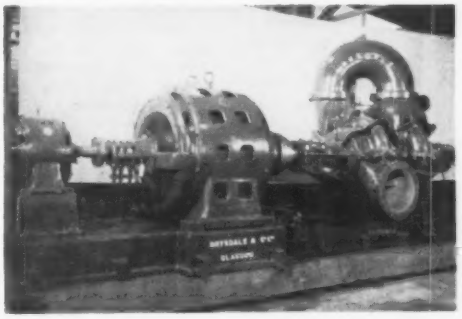
KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	G.E.	2200/440 AC	600 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	Gen. Elec.*(2)	220/440 AC	250 DC
75	Gen. Elec.	220/440 AC	250 DC
75	G.E.	220/440 AC	125 DC
60	Allis Ch.	220/440 AC	250 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC
30	G.E. (2)	220/440 AC	250 DC

Arthur Wagner Co.

Certified

MO nroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

2 DRYSDALE ELECT. DRIVEN 2 STAGE H/L CENTRIF. PUMPS 20" SUCTION 18" DISCHARGE



Each unit:—10,000 gallons per minute 271 ft. Head, externally controlled cutwater mechanism, Wellman Bibby Flexible Coupling. 850 BHP, 2200 volt, 3 phase, 60 cycle, 900 RPM motor, all on heavy base. These are modern units completely rebuilt, suitable for irrigation or municipal waterworks.

ALSO 26,000 feet new pipe 30 inch O.D. 5/16 inch wall, 35-45 foot lengths.

GENERAL MACHINERY LIMITED

GRANVILLE ISLAND **VANCOUVER, B. C.**

ADVERTISERS INDEX

This index is a service to readers. Every effort is made to maintain its accuracy, but POWER cannot assume responsibility for errors or omissions. When a star appears after the name, the advertisement does not appear in this issue but appeared in an issue within the previous three months.

Air Preheater Corp. 41
Alco Products, Inc. 64
Allen-Sherman-Hoff Co. Second Cover
Allgemeine Elektricitats-Gesellschaft *
Allis-Chalmers Mfg. Co. 10-11, 33-34-35-36, 159
Allpax Company, Inc. 222
Aluminum Company of America 73
American Blower Corp. 114, 239
American Engineering Co. 251
American Gilsonite Co. 68
American Pulverizer Co. 232
Ames Iron Works, Inc. *
Anchor Packing Co. 219
Armstrong Machine Works 149
Atomics International, Div. of North American Aviation, Inc. 213
Automatic Switch Company 189

Babbitt Steam Specialty Co. *
Babcock & Wilcox Co. 6-7, 229
Babcock & Wilcox Co. Tubular Products Div. 74
Babcock & Wilcox Co. Tubular Products Div., Fittings Dept. *
Badger Mfg. Co. *
Bailey Meter Company 12-13
Baldwin-Hill Co. 225
Baltimore & Ohio Railroad 185
Bell & Gossett Co. 72
Belmont Packing & Rubber Co. 180
Betz Laboratories 53
Biddle Co., James G. *
Bigelow Co. 190
Bituminous Coal Institute 46-47
Black, Sivalls & Bryson, Inc. 173
Blaw-Knox Co. Blaw-Knox Equipment Div. *
Blaw-Knox Co. Power Piping & Sprinkler Div. 274
Boiler Tube Co. of America 210
Bridgeport Brass Co. 193
Brown Boveri Corp. 215
Buell Engineering Co. 204
Buffalo Forge Co. 42-43
Buffalo Pumps, Inc. *
Bussmann Mfg. Co. *

Carpenter Steel Co., Alloy Tube Div. *
Catawissa Valve & Fittings Co. 228
Celanese Corp. of America Chemical Div. *
Chesapeake & Ohio Railway *
Chesterton Co., A. W. 198
Chicago Pneumatic Tool Co. *
Clarage Fan Co. 243
Clark Bros. Co. One of The Dresser Industries *
Cleaver-Brooks Co., Boiler Div. 178
Cochrane Corporation *
Combustion Engineering, Inc. 54-55
Condenser Service & Engrg. Co. *
Cooper-Bessemer Corp. *
Copes-Vulcan Div., Blaw-Knox Company 14-15
Coppus Engineering Corp. 71
Corning Glass Works 70
Crane Company 165
Crane Packing Company 214
Crawford Fitting Co. 244
Curtiss-Wright Corp. Metal Processing Div. *
Cyclotherm Div., National-U.S. Radiator Corp. *

Darling Valve & Mfg. Co. *
Davis Engineering Corp. *
Dearborn Chemical Co. 259
DeLaval Steam Turbine Co. 2
Detroit Controls Corp. *
Detroit Stoker Co. 157
Diamond Power Specialty Corp. 8-9, 194
Dodge Mfg. Corp. 268
Dow Chemical Co. 241
Dow Corning Corp. 254
Dravo Corporation *
Dwyer Mfg. Co., F. W. *

Edward Valves, Inc. 57-58-59-60-61-62-63
Eichleay Corp. 261
Electric Machinery Mfg. Co. *
Elgin Softener Corp. 263
Elliott Company 169
Elliott Company—Roto Plant 196
Engineer Company 212
Equipto Div. of Aurora Equip. Co. *
Erico Products, Inc. *
Erie City Iron Works 44-45
Ernst Water Column & Gage Co. 222

Fairbanks Co. 240
Fibreboard Paper Prods. Corp., Pabco Ind. Insulations Div. *
Fisher Governor Co. 69
Flexitallic Gasket Co. *
Foster Wheeler Corp. 28-29, 163
Foxboro Company *
Frick Company *
Fuller Company 275

Garlock Packing Company 20-21
Gates Rubber Co. *
General Controls *
General Electric Co. Apparatus Dept. 186-187, 231
General Motors Corp., Electro-Motive Div. 38-39
Goulds Pumps, Inc. *
Green Fire Brick Co., A. P. *
Grinnell Company Third Cover

Hagan Chemicals & Controls, Inc. 66, 209, 273
Harbison-Walker Refractories Co. *
Hartman-Walsh 282
Hays Corporation 184
Henszey Company *
Hewitt-Robins *
Heyl & Patterson, Inc. *
Hilliard Corp. *
Hoffman Specialty Mfg. Corp. 211

I-T-E Circuit Breaker Co. 265
Illinois Water Treatment Co. 212
Industrial Instruments, Inc. *
Infilco Inc. 246
Ingersoll-Rand Co. 48
International Nickel Co., Inc. 257
Iron Fireman Mfg. Co. 67

Jeffrey Mfg. Co. *
Jenkins Bros. 153
Jerguson Gage & Valve Co. *
Johns-Manville 161, 235
Johnson Service Co. 248
Jones & Laughlin Steel Corp. 247

Keasbey & Mattison Co. 277
Keeler Co., E. *
Kennedy-Van Saun Mfg. & Engrg. Corp. *
Kewanee Boiler Div. 24-25
Kieley & Mueller, Inc. 217
Kirk & Blum Mfg. Co. 216
Kittell Muffler & Engrg., Inc. *
Klinger, Inc., Richard *
Koppers Co., Inc. Aeromaster Fan Dept. 210
Koppers Co., Inc. Coupling Dept. 52
Kunkle Valve Co. 282

Laclede Stoker Co. 220
Ladish Co. Between 204-209
Layne & Bowler Pump Co. 200
Leeds & Northrup Company 255
Leslie Company *
Limitorque Corp. 233
Link-Belt Company 1
Lockett & Company, Ltd., A. M. *
Lonergan Co., J. E. 234
Lukens Steel Co. 37
Lunkenheimer Company 191

Manning, Maxwell & Moore, Inc. 201
Marley Company *
Marsh Instrument Co. 272
Mason-Neilan Div. of Worthington 76-77
McDonnell & Miller, Inc. 238
McGraw-Hill Book Co. 234
McNally-Pittsburg Mfg. Corp. 176
Mettler Co., Inc. Div. of Eclipse Fuel Engrg. Co. *
Midcontinent Tube Service, Inc. 282

Midwest Piping Co., Inc. ... 167
Minneapolis-Honeywell Regulator Co., Industrial Div. ... 226-227
Minnesota Mining & Mfg. Co. ... *
Miracle Adhesives Corp. ... 292
Monsanto Chemical Co. Organic Chemicals Div. ... 271
Murray Iron Works Co. ... 175, 249
Murray Mfg. Co., D. J. ... *

National Airoil Burner Co., Inc. ... 236
National Aluminate Corp. ... 155
National Tube Div. ... 270
Nelson Company ... 222
Niagara Blower Co. ... 228
Nicholson & Co., W. H. ... 264
Nordberg Mfg. Co. ... *

Ohio Brass Company ... 177
Ohio Injector Company ... 26-27
Okonite Company ... 56
Orr & Sembower, Inc. ... *

Patterson-Kelley Co. ... 197
Peabody Engrg. Corp. ... *
Peerless Pump Div. Food Machy. & Chemical Corp. ... 267
Pennsylvania Flexible Metallic Tubing Co. ... 238
Permutit Company ... 230
Philadelphia Gear Works, Inc. ... 179, 233
Philadelphia Pump Div. of Amer. Meter Co. ... 192
Phoenix Mfg. Co. (Flange & Forging Div.) ... 269
Pioneer Service & Engineering Co. ... 188
Pittsburgh Piping & Equipment Co. ... 78
Porter Co., Inc., H. K. Forge & Fittings Div. ... *
Porter Co., Inc., H. K. Quaker Rubber Div. ... *
Powell Co., Wm. ... 221
Powers Regulator Co. ... 181
Prat-Daniel Corp. ... 276
Pratt Company, Henry ... *

R-P & C Valve Div. Amer. Chain & Cable Co., Inc. ... 260
Raybestos-Manhattan, Inc. Manhattan Rubber Div. ... *
Raybestos-Manhattan, Inc. Packing Div. ... 202
Reliance Gauge Column Co. ... *
Republic Flow Meters Co. ... 30-31
Republic Steel Corp. ... *
Research Cottrell, Inc. ... 22-23
Revere Copper & Brass, Inc. ... *
Ric-Wil Incorporated ... *
Ridge Tool Company ... 182-183
Riley Stoker Corporation ... 112-113
Rohm & Haas Co. ... *
Ross Heat Exchanger Div. ... 32

Sarco Company ... 237
Scovill Mfg. Co. ... *
Sinclair Refining Co. ... 65
Smith Company, S. Morgan ... *
Smith Corporation, A. O. ... *
Solar Aircraft Co. ... 40
Spence Engineering Co. ... 252
Standard Oil Co. of Indiana ... 199
Stickle Steam Specialties Co. ... *
Stock Equipment Co. ... *

Taylor Instrument Companies ... *
Terry Steam Turbine Co. ... 245
Texas Company ... 4
Trerice Co., H. O. ... 276
Troy Engine & Machine Co. ... *
Tube-Turns, Inc. ... *

Union Asbestos & Rubber Co. ... 262
Union Iron Works ... 256
United States Gauge ... *
United States Steel Corp. ... 253
Universal Atlas Cement Co. ... 250

Viking Pump Co. ... 242
Virginia Gear & Machine Corp. ... 179
Vogt Machine Co., Henry ... 223

W-K-M Div. of ACF Industries ... *
Wallace & Tiernan, Inc. ... *
Walworth Company ... 16
Warren Pumps, Inc. ... *
Webster Mfg. Co. ... 48
Western Chemical Co. ... 224
Western Precipitation Corp. ... *
Westinghouse Electric Corp. ... 17-18-19
Westinghouse Electric Corp. Sturtevant Div. ... 195
Wheeler Mfg. Co., C. H. ... 258
Where to Buy ... 282
Wickes Boiler Co. ... *
Wing Mfg. Co., L. J. ... 218
Wolverine Tube Div. of Calumet & Hecla, Inc. ... 203
Worthington Corp. ... Back Cover
Wright-Austin Co. ... *

Yarnall-Waring Company ... 50-51, 143
York-Shipley, Inc. ... *
Yuba Heat Transfer Div. ... 266

Zallea Brothers ... *
Ziegler & Co., G. S. ... *

Professional Services ... **282**

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES ... 283

EQUIPMENT
(Used or Surplus New)
For Sale ... 283-289

WANTED
Equipment ... 283

ADVERTISERS INDEX

Aljon Electrical Diesel Co. ... 283
American Air Compressor Corp. ... 288
Aurora Laundry ... 283

Belyea Co., Inc. ... 285, 289
Benson-Wilimzig Inc. ... 286
Boston Metals Co., Inc. ... 284, 286, 287

Carlinville Area Hospital ... 283
Chicago Electric Co. ... 284

DeRose, G. M. ... 284
Discophone Sales Co., Inc. ... 283

Ellis Co., A. Lee ... 287
Euclid Eng. Corp. ... 286

Foster Co., L. B. ... 288

General Machinery Ltd. ... 289

H & P Machinery Co. ... 286
Hall & Co., Stephen ... 288
Heat & Power Co., Inc. ... 284
Henault Co., Philip A. ... 283

International Power Machinery Co. ... 283, 284, 288

Jay, Paul ... 283
Joliet Equipment Corp. ... 284

Nagle-Hart Tractor & Eqpt. Co. ... 286
Nantucket Gas & Electric Co. ... 283

Oberman, Paul ... 283

Pelnik-Loconti Industrial Supply Co. ... 287
Power Equipment Co. ... 286

Schoonmaker Co., Inc., A. G. ... 286
Soul Clinic Inc. ... 283

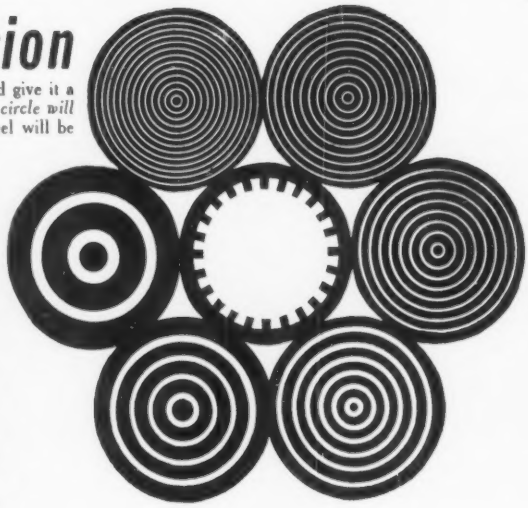
Trubek Laboratories Inc. ... 203

Universal Power & Engineering Co. ... 286
Utilities Machinery Corp. ... 286

Wagner Co., Arthur ... 289
Weaver, Charles ... 284, 287
Whisler Equipment Co. ... 284

This is an illusion

HOLD this Diagram by the right hand bottom corner and give it a slight but *rapid* circular twisting motion, at which time *each circle will separately revolve on its own axis*. The inner cogged wheel will be seen to revolve in an opposite direction.



THIS *is the real thing!*

insul-fil® the most highly efficient and economical "poured-type-insulation" available for underground steam and hot water distribution systems

The following comparative "K" factors were recorded at the Research and Development laboratories of the Atlantic Refining Company, and are evidence of INSUL-FIL's superiority.

The average "K" factor at 150 p.s.i.g. indicated the following values. These values were computed using 6" of material for the comparative evaluation. The average "K" factor on INSUL-FIL and 100% mined asphalt vary slightly depending on thickness of application

"K" VALUES:

PERLITE	.39
INSUL-FIL	.451
100% MINED ASPHALT	.74
SOIL	3.12

Installing contractor Rhode Island Covering Co., U. S. Naval Air Station, Quonset Point, R. I., Charles A. Maguire and Associates, Consulting Engineers, Boston, Mass., Providence, R. I.

Installing INSUL-FIL at Idlewild International Airport for Port of New York Authority. (Seelye, Stevenson, Value & Knecht — Consulting Engineers)

COLLEGES and INDUSTRY use *insul-fil*. Can you afford not to?

INSUL-FIL CO., INC. A DIVISION OF
MIRACLE ADHESIVES CORPORATION 250 Pettit Avenue, Bellmore, L. I., N. Y.

Send now for your **FREE** copy of MIRA-DATA SHEET #9, 4 page colorful brochure describing INSUL-FIL.

NAME_____

COMPANY_____

ADDRESS_____

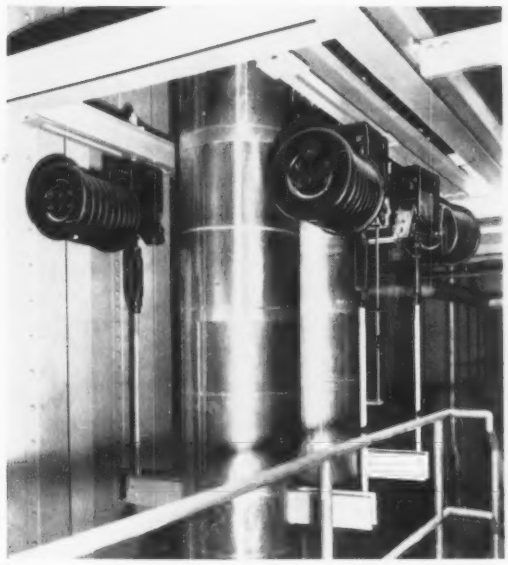
CITY_____ ZONE_____ STATE_____

FIELD ENGINEERS AVAILABLE FOR TECHNICAL ADVICE —

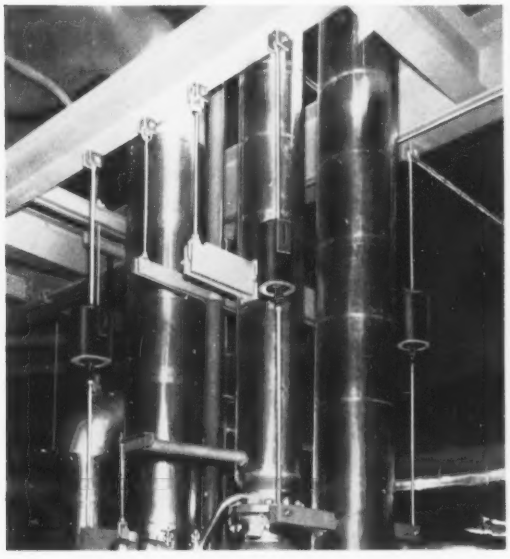
Other Miracle Products for the Insulation Industry:

Zip-on Protektinsul Vinyl Pipe Covering
Zip-on Protekto-Flex, Vinyl Covered Fibrous Glass Insulation
Miracle Surface Anchors
Miracle Insulation Adhesives
Miracle Duct Sealer

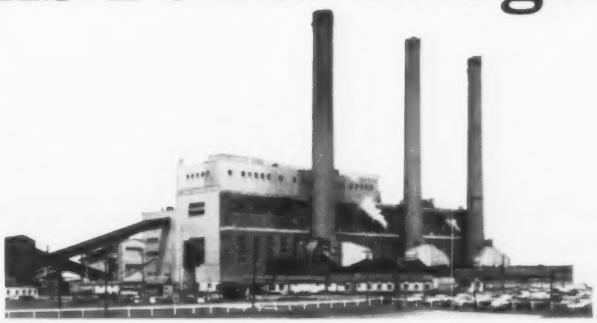
For Indianapolis Power & Light



Grinnell Model R Constant-Support Hangers on cold reheat riser piping. Constancy of support which hangers provide is mathematically perfect for all positions of travel. Note low headroom requirement. Hangers available in sizes for loads ranging from 30 lbs. to 32,260 lbs., with travels up to 12 inches.



Grinnell B-268 Pre-Engineered Spring Hangers on boiler feed piping. Patented precompression feature assures operation of spring within its proper working range. Maximum variation in supporting force per ½" of deflection is 10½% of rated capacity — in all sizes. Available in 21 sizes for loads ranging from 50 lbs. to 28,200 lbs.



H. T. Pritchard Generating Station, Indianapolis Power & Light Company

Pipe Hangers by Grinnell

Six generator units have been built at H. T. Pritchard Station of Indianapolis Power and Light Company since 1947, adding up to a total station capacity of 376,000 kw. In each unit built at this station, just as in every new station constructed by this company, Grinnell Pipe Hangers and Supports have been used exclusively.*

There's good reason why major power companies like Indianapolis Power & Light look to "America's #1 Supplier of Pipe Hangers and Supports." A volume producer of pipe hangers, Grinnell backs up this advantage with an efficient coast-to-coast distribution system of warehouses and jobbers. You can depend on Grinnell for quick deliveries. In fact, even complex hanger requirements often can be met with hanger assemblies right off the shelf. This not only saves you time — but it can save you money, by cutting down on the number of special items which must be manufactured.

Benefit from expert knowledge gained during more than a century of piping experience. On your next piping job, specify Grinnell.

*Work done in collaboration with Gibbs & Hill, Inc., N.Y.C.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPLIES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

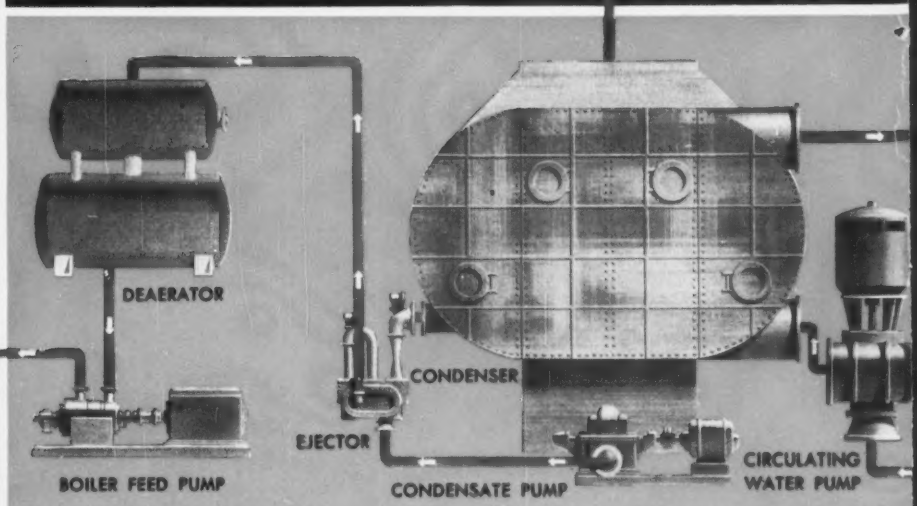
pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

1. STEAM GENERATING GROUP

BOILER

2. ELECTRIC GENERATING GROUP

TURBINE GENERATOR



3. FLUID HANDLING GROUP

LOOK AT ALL THREE FOR POWER

Power plant reliability often depends on the effect of one component of the *Fluid Handling Group* on another. As the manufacturer of all major components of this group, Worthington has a reservoir of experience and knowledge that can benefit you. This "system-wise experience" with modern complex plant equipment can help solve your fluid handling problems. To put "system-wise experience" to work get in touch with your nearest district office. Worthington Corporation, Harrison, New Jersey.

45-3

WORTHINGTON